

**UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

KAIFI LLC,

Plaintiff,

v.

AMAZON.COM, INC.; AMAZON.COM
SERVICES LLC; and AMAZON WEB
SERVICES, INC.

Defendants.

Case No. 2:24-cv-00542

JURY TRIAL DEMANDED

**PLAINTIFF KAIFI LLC'S P.R. 3-1 AND 3-2 DISCLOSURE OF
ASSERTED CLAIMS AND INFRINGEMENT CONTENTIONS AND
ACCOMPANYING DOCUMENT PRODUCTION**

Pursuant to Local Patent Rules 3-1 and 3-2 and the Court's Scheduling Order, Plaintiff KAIFI LLC ("KAIFI") hereby provides its disclosure of asserted claims and infringement contentions against Defendants Amazon.com, Inc., ("Amazon.com"), Amazon.com Services LLC ("Amazon Services"), and Amazon Web Services, Inc. ("Amazon AWS"), including by reference the entirety of the attached appendices and exhibits, and accompanying document production.

KAIFI makes these disclosures based on the information that is presently known and publicly available, without the benefit of discovery. KAIFI has not completed its preparation for trial and has not received discovery from Defendants or third parties, particularly of confidential, proprietary and/or non-public documents and information that describe the accused instrumentalities, or discovery on past, discontinued or other instrumentalities reasonably similar to the presently accused instrumentalities.

KAIFI's investigations are ongoing. KAIFI reserves the right to amend, supplement or otherwise revise its asserted claims and infringement contentions, including but not limited to identification of infringed patents and claims, and infringing instrumentalities.

I. Asserted claims

Pursuant to P.R. 3-1(a), KAIFI presently identifies each claim of each patent in suit that is infringed by Defendants as follows:

U.S. Patent No. 8,930,196 (the "'196 Patent"): claims 1-20;

U.S. Patent No. 8,040,232 (the "'232 Patent"): claims 1-12;

U.S. Patent No. 11,082,518 (the "'518 patent"): claims 1-20; and

U.S. Patent No. 7,689,001 (the "'001 Patent"): claims 1-3, 5, 7-8, 10-11.

II. Accused Instrumentalities

Pursuant to P.R. 3-1(b), KAIFI presently identifies the accused apparatus, product, device, process, method, act, or other instrumentality of which it is aware. This identification is

as specific as possible. Each product, device, and apparatus is identified by name or model number, if known. Each method or process is identified by name, if known.

The accused instrumentalities for the '196 Patent include at least methods and apparatuses for speech recognition, including but not limited to wake word detection. The accused instrumentalities for the '232 Patent include at least sensor node and network methods, apparatuses, and systems, including but not limited to Ubiquitous Sensor Network (USN) middleware. The accused instrumentalities for the '518 Patent include at least systems for multiple machines, including but not limited to a relation server and relation profile, such as for tasks and routines. The accused instrumentalities for the '001 Patent include at least methods and devices for location recognition, including but not limited to autonomous mobile robotics.

Appendix A provides an exemplary list of accused instrumentalities, as corresponding to each of the '196 Patent, '232 Patent, '518 Patent, and '001 Patent.

The accused instrumentalities may be provided in a variety of configurations, embodiments, or combinations of the claimed components and steps. The accused instrumentalities may incorporate various devices, servers, chips, circuit elements, modules, code, and the like. Different models, versions, or iterations may incorporate or embody the same or substantially similar components or configurations.

KAIFI reserves the right to identify additional accused instrumentalities as discovery commences and its investigation continues. KAIFI anticipates the full scope of configurations or combinations of the accused and reasonably similar instrumentalities will be further identified as discovery commences and investigation continues.

III. Claim Charts

Pursuant to P.R. 3-1(c), KAIFI provides claim charts, which are incorporated by reference as if fully set forth herein, identifying where each element of each asserted claim is

found within each accused instrumentality:

Appendix B – the '196 Patent;

Appendix C – the '232 Patent;

Appendix D – the '518 Patent; and

Appendix E – the '001 Patent.

The accused instrumentalities utilize the same or substantially similar technology as presented in the charts, such that the charts are representative of the manner of infringement by each accused instrumentality. On information and belief, the charting of elements of the asserted claims to the accused instrumentalities is substantially the same. The comparisons made in these contentions are representative of, and apply to, all accused and reasonably similar instrumentalities and their configurations and implementations.

The charts subdivide the asserted claims to better illustrate where each claim element or step may be found within the accused instrumentalities. The annotations to figures are provided solely for illustrative purposes. References and descriptions provided in conjunction with one claim within a chart are applicable to other claims within the chart with respect to the same or similar elements and limitations. These subdivisions or annotations should not be taken as an indication of the boundaries of claim elements or steps with respect to the doctrine of equivalents or any other issue. For example, particular claim structures or functionalities may be embodied by or distributed over one or more elements or functional blocks, including or in addition to those that have been annotated. KAIFI reserves the right to provide alternate claim mapping, and to amend, supplement or otherwise revise these charts as discovery and its investigation continues.

IV. Contentions

A. Direct Infringement

KAIFI contends that Defendants directly infringe the asserted claims by making, using, selling, and/or offering for sale in the United States, and/or importing into the United States, this State, and this District the accused instrumentalities, without authority. KAIFI also contends that Defendants' infringement is literal and/or under the doctrine of equivalents.

For example, on information and belief, and without the benefit of discovery, KAIFI presently contends: Amazon.com directly infringes the '196 Patent, the '232 Patent, the '518 Patent, and the '001 Patent; Amazon Services directly infringes the '196 Patent, the '232 Patent, the '518 Patent, and the '001 Patent; and Amazon AWS directly infringes at least the '196 Patent and the '232 Patent.

Additionally or alternatively, each Defendant directs or controls the performance by others (either another Defendant or third party) of one or more claim limitation(s), such that the performance or use of each claim limitation can be attributed to the Defendant. In particular, Defendants condition participation in an activity or receipt of a benefit upon performance of the step(s) and establish the manner or timing of that performance. For example, Amazon Services directs or controls Amazon AWS's performance of certain steps of the claimed methods. Furthermore, Amazon AWS directs or controls Amazon Service's performance of certain steps of the claimed methods.

Additionally or alternatively, Amazon.com, Amazon Services and/or Amazon AWS act as a joint enterprise whose members can be charged with each other's acts in the enterprise. For example, a joint enterprise exists between or among Defendants by virtue of agreement, express or implied, between or among Defendants with a common purpose to be carried out. There exists a community of pecuniary interest in that there is a common purpose among the members with an equal right among all members to a voice in the direction of the enterprise, giving equal

right to control.

Additionally or alternatively, each Defendant has, at least, used the claimed system or apparatus by putting the system or apparatus as a whole into service, *i.e.*, controlled the system and obtained benefit from it. For example, at least Amazon Services, including its employees, have put systems for multiple devices, machines, or components, including but not limited to local devices and back-end servers, as a whole into service, *i.e.*, controlled the system and obtained benefit from it.

Additionally or alternatively, Defendants have directly infringed by combining all elements of the infringing systems, devices, and other instrumentalities together, including via Defendants' software connecting the claimed devices. Further, Defendants directly infringe because they are the single supplier of the accused system where it comprises multiple devices and software.

B. Indirect Infringement

KAIFI contends that Defendants indirectly infringe by actively, knowingly, and/or intentionally inducing and/or contributing to the direct infringement of the asserted claims.

Defendants have induced and continued to induce infringement of the asserted claims by others (either other Defendants or third parties, including end-users and customers). By way of non-limiting examples, (i) Amazon Services induces Amazon AWS's performance of the claimed method or use of a claimed system or apparatus; (ii) Amazon AWS induces Amazon Service's performance of the claimed method or use of a claimed system or apparatus; (iii) Amazon Services or Amazon AWS induces direct infringement by an end-user or customer; and/or (iv) Amazon.com induces direct infringement by Amazon AWS and/or Amazon Services.

Additionally or alternatively, Defendants' customers and/or end-users have used the claimed systems by putting the claimed system as a whole into service, *i.e.*, controlled the system and obtained benefit from it and were induced to do so by Defendants.

Defendants had knowledge or were on notice of the asserted patents by virtue of pre-suit communications between Amazon and PowerVoice, citations to one or more of the asserted patents during the prosecution of patent applications by Defendants and/or their affiliates, and the filing of the complaint in this case.

The acts of inducement may include making, selling, offering to sell, and/or importing the Accused Instrumentalities to or for others, and providing others with encouragement, instructions and training on how to use the accused instrumentalities in a manner that directly infringes the claims, all while Defendants have knowledge of the asserted patents and asserted claims, and knowledge that such use of the accused instrumentalities would infringe the asserted claims. Defendants affirmatively act with knowledge and specific intent to encourage and facilitate such infringing acts by others. Defendants' tutorials, user guides, and technical and marketing documentation for the accused instrumentalities provide specific instruction for using, and actively encourage others to use, the accused instrumentalities in an infringing manner.

Affirmative acts of inducement include, but are not limited to, any one or combination of encouraging and/or facilitating the infringement of others through advertisement, marketing, and dissemination of the accused instrumentalities and their components; creating and publishing promotional and marketing materials, supporting materials, product manuals, and/or technical support and information relating to the accused instrumentalities; describing to, training, and instructing users on the implementation of the accused instrumentalities and/or its components; and providing product manuals and other technical information that cause other Defendants, Defendants' customers and other third parties to use and/or operate the accused instrumentalities for their ordinary and customary use.

Defendants took active steps to encourage end users to use and operate the accused

instrumentalities despite knowing of the asserted patents, in a manner they knew directly infringements each element of the asserted claims. Defendants specifically intended and were aware that the ordinary and customary use of the accused instrumentalities and/or their components would infringe one or more of the asserted claims.

Defendants knew that the induced conduct would constitute infringement and intended said infringement at the time of committing the aforementioned acts, such that those acts and conduct have been and continue to be committed with the specific intent to induce infringement, or to deliberately avoid learning of the infringing circumstances at the time these acts were committed, so as to be willfully blind to the induced infringement.

Defendants have and continue to contributorily infringe the asserted claims by using, offering to sell, selling, or importing the Accused Instrumentalities. The accused instrumentalities in operation form a component of a machine, manufacture, combination, or composition, constituting a material part of the invention for each of the asserted patents. Defendants know that the Accused Instrumentalities are especially made or adapted for use in an infringement of the asserted claims, and that the Accused Instrumentalities are not a staple article or other system capable of substantial non-infringing use.

C. Doctrine of Equivalents

KAIFI contends that Defendants infringe under the doctrine of equivalents, to the extent that Defendants contend any claim elements or limitations are not found literally. Defendants have not specifically identified which claim elements or limitations they contend are not literally met. Should Defendants contend that any element, step or limitation is literally absent, KAIFI contends and reserves the right to prove that at least the equivalent of the allegedly missing element, step or limitation is nevertheless present and that accused instrumentalities at least infringe under the doctrine of equivalents. KAIFI anticipates that discovery will enable it to set

forth the additional scope of equivalents, and therefore reserves the right to amend, supplement or otherwise revise these contentions, and specifically as to the doctrine of equivalents.

V. Priority Dates

Pursuant to P.R. 3-1(e), Plaintiff identifies the priority date to which each asserted claim is entitled for asserted patents that claim priority to an earlier application.

- The asserted claims of '196 claim priority to PCT Appl. PCT/KR2009/002118 filed April 22, 2009.
- The asserted claims of '232 claim priority to PCT Appl. PCT/KR2006/005715 filed December 26, 2006.
- The asserted claims of '518 claim priority to US Appl. 14/931,213 filed November 3, 2015.
- The asserted claims of '001 claim priority to KR Appl. 10-2005-0114022 filed November 28, 2005.

KAIFI's investigation is continuing. KAIFI reserves the right to supplement its priority claim date (and to assert any applicable prior invention dates).

VI. Plaintiff's Practicing Instrumentalities

Pursuant to P.R. 3-1(f), at this time, KAIFI is not asserting that any apparatus, product, device, process, method, act, or other instrumentality of its own practices any of the claimed inventions. KAIFI's investigation is continuing. To the extent that additional responsive, discoverable information is found, including with respect to third parties, KAIFI reserves the right to and will supplement its response concerning P.R. 3-1(f) as appropriate.

VII. Document Production

Pursuant to P.R. 3-2(a), KAIFI is producing the following non-privileged documents sufficient to evidence each discussion with, disclosure to, or other manner of providing to a third party, or sale of or offer to sell, the claimed invention prior to the date of application for the patent in suit:

Bates Nos. KAIFI0007448 - KAIFI0007495; KAIFI0007509 - KAIFI0007579;
KAIFI0007673 - KAIFI0007691.

Pursuant to P.R. 3-2(b), KAIFI is producing herewith non-privileged documents evidencing the conception, reduction to practice, design, and development of each claimed invention, which were created on or before the date of application for the patent in suit or the priority date identified pursuant to P. R. 3-1(e):

Bates Nos. KAIFI0007448 - KAIFI0007691.

Pursuant to P.R. 3-2(c), KAIFI is producing herewith a copy of the file history for each of the Asserted Patents:

Bates Nos. KAIFI0000001 - KAIFI0001071.

KAIFI reserves the right to amend or supplement this production based on further investigation.

Date: November 14, 2024

/s/ Andrew Choung

Jennifer L. Truelove
Texas State Bar No. 24012906
jtruelove@mckoolsmith.com
MCKOOL SMITH, P.C.
104 East Houston Street Suite 300
Marshall, TX 75670
Telephone: (903) 923-9000
Facsimile: (903) 923-9099

Jason G. Sheasby
(*pro hac vice* to be filed)
jsheasby@irell.com
IRELL & MANELLA LLP
1800 Avenue of the Stars, Suite 900
Los Angeles, CA 90067-4276
Telephone: (310) 277-1010
Facsimile: (310) 203-7199

Andrew Choung
(admitted in E.D. Texas)
achoung@nixonpeabody.com
Jennifer Hayes
(admitted *Pro Hac Vice*)
jhayes@nixonpeabody.com
NIXON PEABODY LLP
300 S. Grand Avenue, Suite 4100
Los Angeles, CA 90071
Telephone: (213) 629-6000
Facsimile: (213) 629-6001

Attorneys for Plaintiff KAIFI LLC

CERTIFICATE OF SERVICE

I certify that the foregoing document was served by electronic mail to counsel for Defendants.

Date: November 14, 2024

/s/ Andrew Choung

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1 of the '001 Patent

Claim 1	Accused Instrumentality(ies)
A method for recognizing a location by a mobile terminal having a built-in camera, the method comprising:	Amazon deploys an automation system using location recognition devices at its facilities. For example, Amazon deploys autonomous mobile robots (“AMRs”) having built-in cameras.¹ Amazon first entered the mobile robot space in 2012, when it acquired Kiva Systems for \$775 million. Kiva offered automated guided vehicles (AGVs) that could navigate a warehouse using a series of computerized barcode stickers on the floor. Now, a decade later, Amazon has announced its first fully autonomous mobile robot (AMR), Proteus. Proteus is an AMR with a similar design to the Kiva robots that have been at work in Amazon’s warehouses for years. Proteus can slide under Amazon’s GoCarts, pick them up and move them across the warehouse to employees or other robotic cells, reducing the amount of walking Amazon workers need to retrieve items.

¹ See KAIFI0001125 (Brianna Wessling, *A decade after acquiring Kiva, Amazon unveils its first AMR* (Jun. 22, 2022), <https://www.therobotreport.com/a-decade-after-acquiring-kiva-amazon-unveils-its-first-amr/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	 For example, according to Amazon, it is using at least 750,000 AMRs.²

² See KAIFI0002113 (Joseph Quinlivan, *How Amazon deploys collaborative robots in its operations to benefit employees and customers* (Jun. 26, 2023), <https://www.aboutamazon.com/news/operations/how-amazon-deploys-robots-in-its-operations-facilities>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	 Principal Tech Program Manager, Proteus Lead Mikell Taylor stands next to Proteus, an Amazon robot. 750,000 Amazon robots are doing the heavy lifting for our employees so they can deliver for customers. With the latest in AI, our technology makes our sites safer and enables employee upskilling.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	For over a decade, we've pioneered technology and robotics in our operations, driving innovation and growth that directly benefits our employees and customers. The rate of our innovation has only accelerated, thanks in large part to unprecedented advancements in AI. Throughout the years, we've consistently focused on building safe, practical, and dependable technology and robotics that optimize our supply chain. We're particularly excited about some of the latest collaborative robotics we've developed and announced over the last year. Using the latest in computer vision, and machine learning our newest industrial robots can operate alongside humans safely and include our first autonomous mobile robot, Proteus; new robotic handling systems, specifically Cardinal and Sparrow; and a new approach to inventory management, called <u>Containerized Storage</u>, which uses robots to deliver products to employees in a more ergonomically friendly manner. For example, according to Amazon:³

³ See KAIFI0001291 (Brian Crum, *Amazon Unveils New Fully Autonomous Mobile Warehouse Robots* (Jul. 6, 2023), <https://retailwire.com/discussion/amazon-unveils-new-fully-autonomous-mobile-warehouse-robots/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	 Proteus Robot Photo: Amazon Amazon has unveiled two new fully autonomous mobile warehouse robots, Proteus and Cardinal. The robots are designed to help Amazon employees move products more efficiently and safely in its fulfillment centers. But what do they look like and how are they expected to help? First, we have Proteus, a large, rectangular robot that can carry up to 5,000 pounds of cargo. It is designed to move carts of products around the warehouse floor, freeing up employees to focus on other tasks. Proteus is powered by a battery and can travel up to 10 miles per hour. Both Proteus and Cardinal are designed to work safely alongside human employees. They are equipped with sensors that allow them to detect and avoid obstacles, and they have a slow-moving mode that allows employees to interact with them safely.

Appendix E Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	For example, Amazon has used Kiva.⁴ SQUAT AND SMART Kiva's robots have more than 900 parts, from off-the-shelf dc motors to custom-made ball screws. Here's how the robots' main systems work. PHOTOS: KIVA SYSTEMS NAVIGATION SYSTEM A camera facing upward reads bar codes placed under inventory racks to identify them. Another camera located at the bottom of the robot views bar codes on the floor. This location information is combined with readings from other navigation sensors, such as encoders, accelerometers, and rate gyros. POWER SYSTEM Four lead-acid batteries power the motors and onboard electronics. When batteries run low, the robot automatically drives to a charging station. DRIVING SYSTEM Two brushless dc motors control independent neoprene rubber wheels, moving the robot at 1.3 meters per second. LIFTING MECHANISM A large screw turns to raise racks of inventory 5 centimeters from the ground. At the same time, the wheels make the robot rotate in the opposite direction to keep the rack motionless. COLLISION-DETECTION SYSTEM Infrared sensors and touch-sensitive bumpers stop the robot if people or objects get in its way.

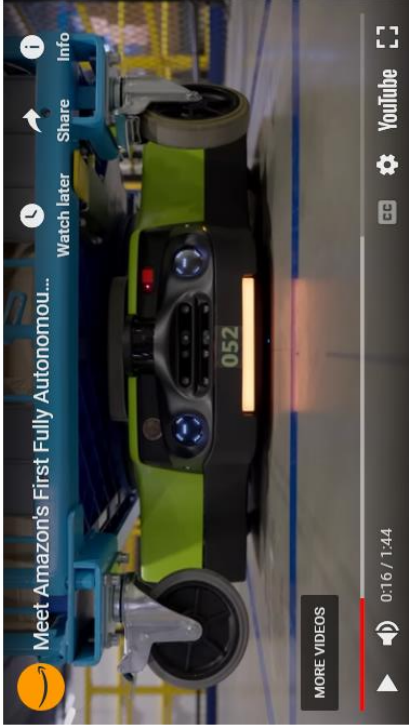
⁴ See KAIFI0004434 (*Squat and Smart* (July 2008), https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=23#/p/22).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	 For example, Amazon has used Proteus.⁵

⁵ See KAIFI0001098 (10 years of Amazon robotics: how robots help sort packages, move product, and improve safety (Jun. 21, 2022), <https://www.aboutamazon.com/news/operations/10-years-of-amazon-robotics-how-robots-help-sort-packages-move-product-and-improve-safety>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	Proteus  Proteus is our first fully autonomous mobile robot. Historically, it's been difficult to safely incorporate robotics in the same physical space as people. We believe Proteus will change that while remaining smart, safe, and collaborative. Proteus autonomously moves through our facilities using advanced safety, perception, and navigation technology developed by Amazon. The robot was built to be automatically directed to perform its work and move around employees—meaning it has no need to be confined to restricted areas. It can operate in a manner that augments simple, safe interaction between technology and people—opening up a broader range of possible uses to help our employees—such as the lifting and movement of GoCarts, the non-automated, wheeled transports used to move packages through our facilities.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	Proteus will initially be deployed in the outbound GoCart handling areas in our fulfillment centers and sort centers. Our vision is to automate GoCart handling throughout the network, which will help reduce the need for people to manually move heavy objects through our facility and instead let them focus on more rewarding work. Proteus has a similar design to Kiva.⁶ Amazon first entered the mobile robot space in 2012, when it acquired Kiva Systems for \$775 million. Kiva offered automated guided vehicles (AGVs) that could navigate a warehouse using a series of computerized barcode stickers on the floor. Now, a decade later, Amazon has announced its first fully autonomous mobile robot (AMR), Proteus. Proteus is an AMR with a similar design to the Kiva robots that have been at work in Amazon's warehouses for years. Proteus can slide under Amazon's GoCarts, pick them up and move them across the warehouse to employees or other robotic cells, reducing the amount of walking Amazon workers need to retrieve items.

⁶ See KAIFI0001125 (Brianna Wessling, *A decade after acquiring Kiva, Amazon unveils its first AMR* (Jun. 22, 2022), <https://www.therobotreport.com/a-decade-after-acquiring-kiva-amazon-unveils-its-first-amr/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	For example, Amazon has used Sequoia.⁷  With all of these efforts underway, it makes us particularly proud to share that we have just launched a new robotic system in time to help fulfill customer orders for holiday shopping this year. Sequoia is the name of this new technology, and it's now operating at one of our fulfillment centers in Houston, Texas.

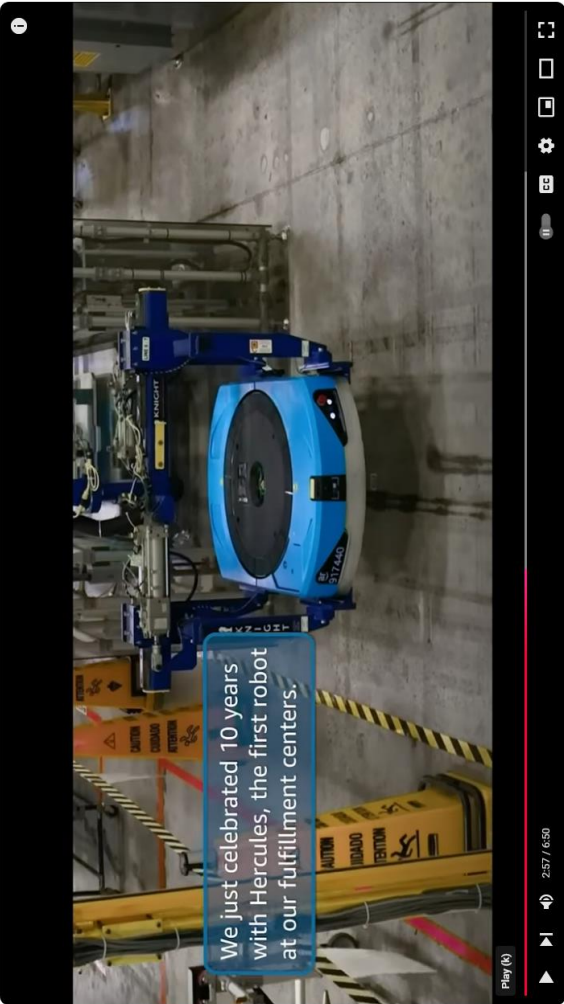
⁷ See KAIFI0001204 (Scott Dresser, *Amazon announces 2 new ways it's using robots to assist employees and deliver for customers* (Oct. 18, 2023), <https://www.aboutamazon.com/news/operations/amazon-introduces-new-robotics-solutions>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	Building off a series of research and development efforts, Sequoia integrates multiple robot systems to containerize our inventory into totes, bringing together mobile robots, gantry systems, robotic arms, and a new ergonomic employee workstation. The system works by having mobile robots transport containerized inventory directly to a gantry, a tall frame with a platform supporting equipment that can either restock totes or send them to an employee to pick out inventory that customers have ordered. These totes come to employees at a newly-designed ergonomic workstation that allows them to do all their work in their power zone, between mid-thigh and mid-chest height. With this system, employees will no longer have to regularly reach above their heads or squat down to pick customer orders, supporting our efforts to reduce the risk of injuries. For example, Amazon has used Hercules.⁸

⁸ See KAIFI0007813 (*Introducing the Full Amazon Robot Line Up* (May 8, 2023), <https://www.youtube.com/watch?v=7SvTdW4OLUQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	 For example, Amazon has used Titan.⁹

⁹ See, KAIFI0007703 (Meet the 8 robots powering your Amazon package deliveries, <https://www.aboutamazon.com/news/operations/amazon-robotics-robots-fulfillment-center>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	3. Titan  Titan Job: Transports large and bulky items to employees Capacity: Can lift up to 2,500 pounds Launched in: San Antonio, Texas, in 2017 Size: 52.1 in. by 36.6 in. by 9.47 in., and weighs around 510 pounds, or slightly smaller than a baby grand piano without legs Similar to Hercules, Titan is another drive unit that brings items from across Amazon's fulfillment centers directly to employees as they assemble customer orders. What's special about <u>Titan</u> is that it can lift twice as much as Hercules, meaning it focuses on larger and/or bulkier items like small household appliances or pallets of food. For example, Amazon has used Pegasus and Xanthus (a/k/a X-bot).¹⁰¹¹

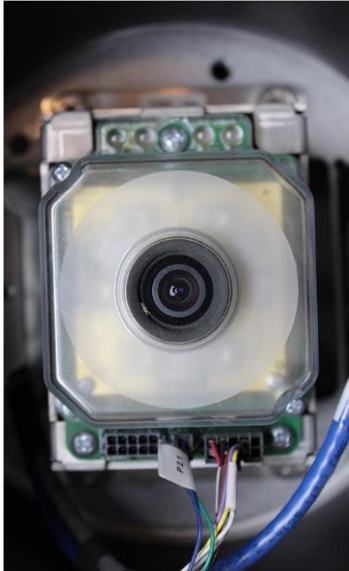
¹⁰ See KAIF10007781 (*Amazon's tiny robot drives do the heavy lifting*, <https://www.amazon.science/latest-news/amazon-robotics-autonomous-drive-units-hercules-pegasus-xanthus-xbot>).

¹¹ See KAIF10007769 (*Amazon Uses 800 Robots to Run This Warehouse*, <https://spectrum.ieee.org/amazon-introduces-two-new-warehouse-robots>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	  Xanthus, one of two new robots Amazon unveiled today, can be equipped with different modules like conveyor belts and stacks of bins to perform a wide variety of tasks. IMAGE: AMAZON

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
a) photographing a location recognition tag storing location recognition information;	The Accused Instrumentalities photograph a location recognition tag storing location recognition information. For example, Kiva comprises a dual-camera imaging module.¹²  On the left: top-facing imager inside the lifter ball screw. On the right: bottom-facing imager once imaging unit is removed.

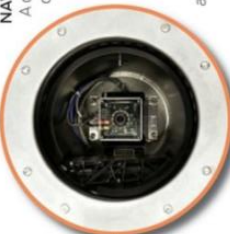
¹² See KAIFI0006779 (Ben Einstein, *Meet the drone that already delivers your packages, Kiva robot teardown* (Feb. 1, 2016), <https://robohub.org/meet-the-drone-that-already-delivers-your-packages-kiva-robot-teardown/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	Tucked inside the lifter mechanism is one of the key enablers of the Kiva system: a dual-camera imaging module. One camera looks down at the ground to recognize 2D barcodes on the warehouse floor. The other looks upwards at the bottom of every pod. Each has 6 on-board red LEDs for illumination and like the rest of the robot, everything is custom designed. Sandwiched between the two imagers is an image processing board sporting an <u>ADI ADSP-BF548</u> Blackfin multimedia processor which is doing the Datamatrix detection and relaying results via high-speed serial. For example, Kiva comprises a navigation system.¹³

¹³ See KAIFI0004434 (*Squat and Smart* (July 2008), https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=23#/p/22).

Appendix E
 Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	 SQUAT AND SMART Kiva's robots have more than 900 parts, from off-the-shelf dc motors to custom-made ball screws. Here's how the robots' main systems work. PHOTOS: KIVA/AL DALLSBERG NAVIGATION SYSTEM A camera facing upward reads bar codes placed under inventory racks to identify them. Another camera located at the bottom of the robot views bar codes on the floor. This location information is combined with readings from other navigation sensors, such as encoders, accelerometers, and rate gyros.  LIFTING MECHANISM A large screw turrs to raise racks of inventory 5 centimeters from the ground. At the same time, the wheels make the robot rotate in the opposite direction to keep the rack motionless.  POWER SYSTEM Four lead-acid batteries power the motors and onboard electronics. When batteries run low, the robot automatically drives to a charging station.  DRIVING SYSTEM Two brushless dc motors control independent neoprene rubber wheels, moving the robot at 1.3 meters per second.  COLLISION-DETECTION SYSTEM Infrared sensors and touch-sensitive bumpers stop the robot if people or objects get in its way.  For example, Kiva comprises cameras that read two-dimensional bar-coded stickers laid out in a grid.¹⁴

¹⁴ See *id.*

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	the system. The robots, he explains, navigate the warehouse by pointing cameras at the floor that read two-dimensional bar-coded stickers laid out by hand 1 meter from each other, in a grid. The robots relay the encoded information wirelessly to a computer cluster that functions both as a dispatcher and a traffic controller. It instructs, for instance, robot No. 1051 to bring rack No. 308 to worker No. 12—without colliding with robot No. 1433, which is crossing its path. For example, Kiva uses a grid of 2D QR codes.¹⁵

¹⁵ See KAIFI0006779 (Ben Einstein, *Meet the drone that already delivers your packages, Kiva robot teardown* (Feb. 1, 2016), <https://robohub.org/meet-the-drone-that-already-delivers-your-packages-kiva-robot-teardown/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	The system Kiva developed comprises on 5 key components: • Custom designed Kiva shelves ("pods") that are mobile and highly flexible • A grid of 2D QR codes implanted on the floor (known as "fiducials") • An intelligent pack station decked out with scales, lasers, and sensors • Herculean orange robots that swiftly lift and move the pods around the floor • And most important of all: a complex and robust software system tying everything together While all these components are amazing in their own right (and necessary for the system to function), this post focuses on the bright orange bots droning around the warehouse floor. For example, Kiva uses a distributed-control approach.¹⁶

¹⁶ See KAIFI0004434 (*Squat and Smart* (July 2008), https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=23#/p/22).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	The control system also reports its readings to the computer cluster to share that information with other robots. This distributed-control approach improves their navigation capabilities. Say a robot sees certain stickers off to the left. Instead of simply correcting its course by turning to the right, the robot first checks what other robots see—what the “wisdom of the crowd” is. If most of them see cen- tered stickers, the robot figures that the stickers are in the right place and that the shift in position is due to inherent imperfections with its own hardware—its camera may be off center or its wheels misaligned. The robot then adjusts its own control parameters to navigate more accurately. In fact, the machines drive so meticulously that their rubber wheels leave precisely aligned tracks on the warehouse floor.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	The greatest advantage of this approach is that the robots are mechanically simpler, and therefore cheaper. Rather than equipping the robots with expensive, high-precision parts to ensure they drive in straight lines, Kiva lets the control software take care of the variations and imperfections in the hardware components. "We don't have to buy the best motors, the best gear boxes to make the robots reliable," says Dennis Polic, one of the electrical engineers. "The control system takes care of that." For example, Proteus utilizes a Simultaneous Localization and Mapping ("SLAM") system.¹⁷ What is an AMR? An Autonomous Mobile Robot, or AMR, is a vehicle that uses on-board sensors and processors to autonomously move materials without the need for physical guides or markers. It learns its environment, remembers its location, and dynamically plans its own path from one waypoint (a location or destination within the environment) to another.

¹⁷ See KAIFI0006774 (*Meet Amazon's First Fully Autonomous Mobile Robot*, <https://www.warehouseautomation.ca/news-notes-1/2022/8/8/meet-amazons-first-fully-autonomous-mobile-robot>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	Features of an AMR: • Navigation: Using technology such as LIDAR sensors & Simultaneous Localization and Mapping (SLAM), an AMR will determine the best route between waypoints • Deployment: This can vary, but great AMRs can be unboxed and put to work in less than 15 minutes • Operational Flexibility: An AMR will dynamically plan the shortest path based on current conditions and requirements, if the work changes from one day to the next, the AMR's route will change with it • Responsiveness: AMRs will automatically sense and avoid obstacles and blocked paths to find the best route to its next waypoint As a further example, Proteus' cameras read barcodes.¹⁸

¹⁸ See KAIFI0007813 (*Introducing the Full Amazon Robot Line Up* (May 8, 2023), <https://www.youtube.com/watch?v=7SvTdW4OLUQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

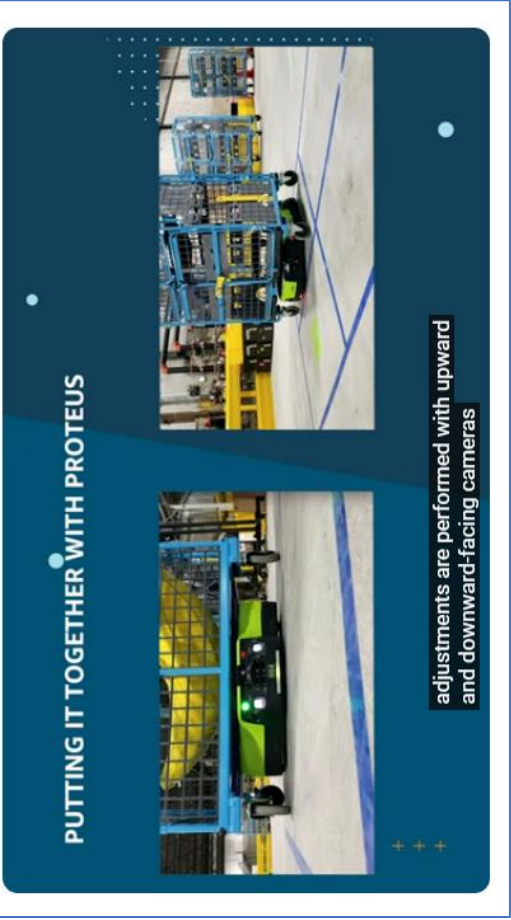
Claim 1	Accused Instrumentality(ies)
	According to Amazon, Proteus is comprised of multiple cameras that read bar-codes.¹⁹

¹⁹ See KAIF10007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E

Claim 1	Accused Instrumentality(ies) STORAGE CELL DETECTION Local perception target – Fiducial Plus • Observable characteristic length • Soft modification Mapping: image plane ↔ ground plane
----------------	---

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

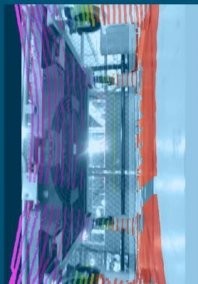
Claim 1	Accused Instrumentality(ies)
	

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	The diagram shows a blue trapezoidal shape representing a field of view. Inside, a smaller blue rectangle is labeled 'Global Slam'. The trapezoid is divided into concentric regions with labels: 1000mm at the top, 100mm below it, 10mm below that, and 1mm at the bottom. The label '1mm' appears twice, once on each side of the bottom section. The diagram shows a blue trapezoidal shape representing a field of view. Inside, a smaller blue rectangle is labeled 'Local Perception'. Below it, a smaller blue rectangle is labeled 'Precision Anchors'. The trapezoid is divided into concentric regions with labels: 100mm at the top, 10mm below it, and 1mm below that. The label '1mm' appears twice, once on each side of the bottom section.

Appendix E

Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	<div data-cs="2" data-kind="parent"> <div data-bbox="311 308 823 1281"> <div data-bbox="376 909 406 1176"> <p>GO CART DETECTION</p> </div> <div data-bbox="420 768 479 1176"> • Local perception target – GoCart itself • Lidar clustering – known geometry </div> <div data-bbox="531 840 727 1121">  </div> <div data-bbox="531 396 727 732">  </div> </div> </div> <div data-bbox="867 573 902 1388"> <p>For example, Amazon’s AMRs photograph Fiducial Plus tags.²⁰</p> </div>

²⁰ *Id.*

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	 STORAGE CELL DETECTION Local perception target – Fiducial Plus • Observable characteristic length • Soft modification Mapping: image plane → ground plane For example, Hercules uses a camera to read markers.²¹ Hercules itself is a fourth-generation drive designed to navigate structured fields, floors that contain a grid of encoded markers. By reading the markers with its downward facing camera, it can find its position and the location of any pod. For example, Titan uses equivalent technologies.²²

²¹ See KAIFI0001072 (4 cool facts about Hercules, the small-but-mighty robot in Amazon's fulfillment centers (September 7, 2023), <https://www.aboutamazon.com/news/operations/amazon-hercules-robot>).

²² See KAIFI0007697 (Introducing Titan, Amazon's new mobile robot that can lift up to 2,500 pounds (November 14, 2023), <https://www.aboutamazon.com/news/operations/amazon-unveils-titan-fulfillment-center-robot>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	Titan integrates several technologies from previous mobile robots, including the battery and charging management solution from Hercules, and the computer vision, obstacle detection, and user control systems from the Xanthus mobile robot. Titan also uses hardware components from Proteus to manage its operating system as it plans, executes, and interfaces with other technologies within the facility. On information and belief, each of Amazon’s AMRs rely on equivalent technologies in relation to their use of location recognition tags and the limitations set forth in this claim chart.²³ Thus, the evidence in this chart applies equally to all AMR iterations identified in this chart. Every day at Amazon fulfillment centers, more than half a million robots assist with stocking inventory, filling orders, and sorting packages for delivery. These robots follow directions provided by cloud-based algorithms and navigate along a grid of encoded markers. Virtual and physical barriers restrict their interactions with people, as well as where they can and cannot go. For example, according to Amazon.²⁴

²³ See KAIF10007714 (*The quest to deploy autonomous robots within Amazon fulfillment centers* (October 24, 2022), <https://www.amazon.science/latest-news/the-quest-to-deploy-autonomous-robots-within-amazon-fulfillment-centers>).

²⁴ See KAIF10007692 (*Inside the Amazon Warehouse Where Humans and Machines Become One*, <https://www.wired.com/story/amazon-warehouse-robots/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	instance, enjoy basking in the photons that pour through skylights. Above the robots' field, though, the skylights are covered, because the glare might throw off the machines' sensors. To navigate, they're using a camera on their bellies that reads QR codes on the ground. Even the air-conditioning units hanging from the roof are modified. On the
b) measuring a distance to the location recognition tag;	The Accused Instrumentalities measure a distance to the location recognition tag. For example, Kiva can determine and adjust its location.²⁵ Their innovation was to put bar-code stickers on the floor and equip the robots with cameras to read them. As the robots move, they read the encoded information to learn their coordinates in the warehouse. At the same time, the robots' control systems determine how far off their bodies are from the center of the

²⁵ See KAIFI0004434 (*Squat and Smart* (July 2008), https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=23#/p/22).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	stickers. If, for instance, a robot is a bit off to the right, the control system nudges it to the left. For example, Kiva's control system determine how far off their bodies are from the center of the stickers.²⁶ Their innovation was to put bar-code stickers on the floor and equip the robots with cameras to read them. As the robots move, they read the encoded information to learn their coordinates in the warehouse. At the same time, the robots' control systems determine how far off their bodies are from the center of the stickers. If, for instance, a robot is a bit off to the right, the control system nudges it to the left. For example, Proteus uses advanced perception and navigation technology²⁷

²⁶ See KAIFI0004451 (*Kiva Systems: Three Engineers, Hundreds of Robots, One Warehouse*, <https://spectrum.ieee.org/three-engineers-hundreds-of-robots-one-warehouse>).

²⁷ See KAIFI0001098 (*10 years of Amazon robotics: how robots help sort packages, move product, and improve safety* (Jun. 21, 2022), <https://www.aboutamazon.com/news/operations/10-years-of-amazon-robotics-how-robots-help-sort-packages-move-product-and-improve-safety>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	Proteus autonomously moves through our facilities using advanced safety, perception, and navigation technology developed by Amazon. The robot was built to be automatically directed to perform its work and move around employees—meaning it has no need to be confined to restricted areas. It can operate in a manner that augments simple, safe interaction between technology and people—opening up a broader range of possible uses to help our employees—such as the lifting and movement of GoCarts, the non-automated, wheeled transports used to move packages through our facilities. For example, Amazon’s AMRs measure distance to Fiducial Plus tags.²⁸ 

²⁸ See KAIF10007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	For example, according to Amazon:²⁹ So now you can see on the right-hand side we have a nice one-to-one mapping from the camera plane down to the ground plane. We use the camera's intrinsics and extra index calibrated in order to get that transformation. This means we can apply a plethora of computer vision techniques segmentation geometry detection to understand this fiducial plus's estimate on the ground plane world in the physical world and then we complete the storage mission. On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation. This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.
c) analyzing an image of the photographed location recognition tag, and obtaining location information corresponding to the location recognition tag;	The Accused Instrumentalities analyze an image of the photographed location recognition tag, and obtaining location information corresponding to the location recognition tag.

²⁹ *Id.* at 7:02.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	For example, Kiva comprises cameras that read two-dimensional bar-coded stickers laid out in a grid.³⁰ the system. The robots, he explains, navigate the warehouse by pointing cameras at the floor that read two-dimensional bar-coded stickers laid out by hand 1 meter from each other, in a grid. The robots relay the encoded information wirelessly to a computer cluster that functions both as a dispatcher and a traffic controller. It instructs, for instance, robot No. 1051 to bring rack No. 308 to worker No. 12—without colliding with robot No. 1433, which is crossing its path. For example, Kiva uses a distributed-control approach.³¹

³⁰ See KAIF10004434 (*Squat and Smart* (July 2008)), [https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=](https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=23#/p/22)

23#/p/22).

³¹ See *id.*

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

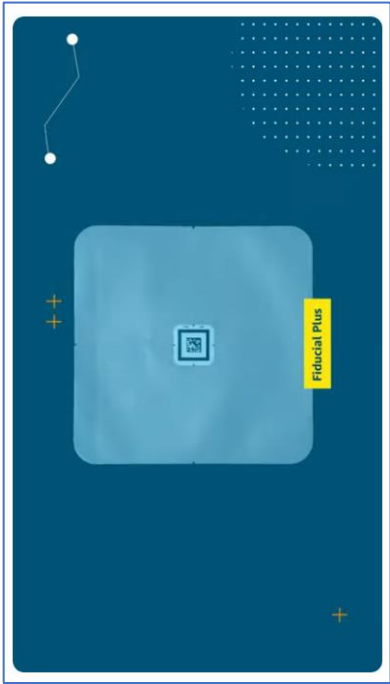
Claim 1	Accused Instrumentality(ies)
	The control system also reports its readings to the computer cluster to share that information with other robots. This distributed-control approach improves their navigation capabilities. Say a robot sees certain stickers off to the left. Instead of simply correcting its course by turning to the right, the robot first checks what other robots see—what the “wisdom of the crowd” is. If most of them see cen- tered stickers, the robot figures that the stickers are in the right place and that the shift in position is due to inherent imperfections with its own hardware—its camera may be off center or its wheels misaligned. The robot then adjusts its own control parameters to navigate more accurately. In fact, the machines drive so meticulously that their rubber wheels leave precisely aligned tracks on the warehouse floor.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	The greatest advantage of this approach is that the robots are mechanically simpler, and therefore cheaper. Rather than equipping the robots with expensive, high-precision parts to ensure they drive in straight lines, Kiva lets the control software take care of the variations and imperfections in the hardware components. "We don't have to buy the best motors, the best gear boxes to make the robots reliable," says Dennis Polic, one of the electrical engineers. "The control system takes care of that." For example, Kiva comprises an image processing board.³²

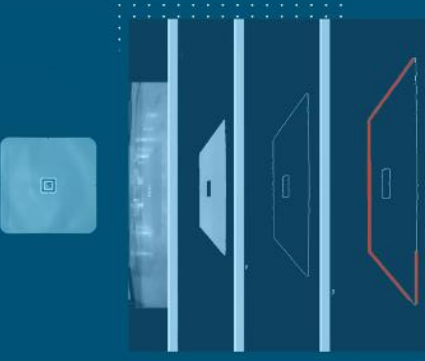
³² See KAIFI0006779 (Ben Einstein, *Meet the drone that already delivers your packages, Kiva robot teardown* (Feb. 1, 2016), <https://robohub.org/meet-the-drone-that-already-delivers-your-packages-kiva-robot-teardown/>).

Appendix E Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	Tucked inside the lifter mechanism is one of the key enablers of the Kiva system: a dual-camera imaging module. One camera looks down at the ground to recognize 2D barcodes on the warehouse floor. The other looks upwards at the bottom of every pod. Each has 6 on-board red LEDs for illumination and like the rest of the robot, everything is custom designed. Sandwiched between the two imagers is an image processing board sporting an ADI ADSP-BF548 Blackfin multimedia processor which is doing the Datamatrix detection and relaying results via high-speed serial. For example, Proteus comprises cameras that read bar-codes.³³ 

³³ See KAIF10007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

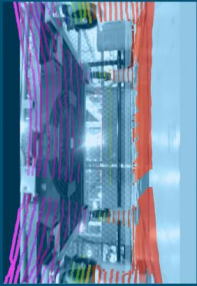
Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	STORAGE CELL DETECTION Local perception target – Fiducial Plus • Observable characteristic length • Soft modification Mapping: image plane ↔ ground plane  PUTTING IT TOGETHER WITH PROTEUS  adjustments are performed with upward and downward-facing cameras

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	The diagram shows a blue square representing a scene. A yellow box labeled "Global Slam" is positioned in the center. The square is divided into four quadrants by a dark blue cross. The top-left quadrant is labeled "1000mm", the top-right "100mm", the bottom-left "10mm", and the bottom-right "1mm". The diagram shows a blue square representing a scene. A yellow box labeled "Local Perception" is positioned in the center. The square is divided into four quadrants by a dark blue cross. The top-left quadrant is labeled "100mm", the top-right "10mm", the bottom-left "1mm", and the bottom-right "1mm".

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	GOCART DETECTION • Local perception target – GoCart itself • Lidar clustering – known geometry  For example, Proteus uses a distributed-control approach.³⁴ <i>Proteus autonomously moves through our facilities using advanced safety, perception, and navigation technology developed by Amazon. The robot was built to be automatically directed to perform its work and move around employees—meaning it has no need to be confined to restricted areas. It can operate in a manner that augments simple, safe interaction between technology and people—opening up a broader range of possible uses to help our employees—such as the lifting and movement of GoCarts, the nonautomated, wheeled transports used to move packages through our facilities.</i>

³⁴ See KAIFI0001260 (Evan Ackerman, *Amazon Shows Off Impressive New Warehouse Robots > It's a lot of progress over just one year* (Jun. 23, 2022), <https://spectrum.ieee.org/amazon-warehouse-robots>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	For example, Proteus utilizes an on-board computer and control boards.³⁵ SENSORS Vision system with cameras and high-precision lidar for perception and navigation, including maneuvering underneath carts and reading fiducials on the ground. Upward and downward-facing cameras to read barcodes. Other collision-avoidance sensors. COMPUTE On-board computer and control boards. Colored lights and LED "eyes" for human-robot interaction. SOFTWARE Custom robot control system. Integrated with fleet management software stack and Amazon's warehouse management systems. ACTUATORS Motors to drive wheels and power lifting mechanism. For example, Amazon's AMRs analyze Fiducial Plus tags to obtain location information corresponding to those tags.³⁶

³⁵ See KAIFI0006967 (*Proteus*, <https://robotsguide.com/robots/proteus>).

³⁶ See KAIFI0007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	According to Amazon:³⁷ Transcript: next we'll talk about this new fiducial plus which is a custom-made ground target which allows us to detect storage cells and do precision alignment. So now you can see on the right-hand side we have a nice one-to-one mapping from the camera plane down to the ground plane. We use the camera's intrinsic and extra index calibrated in order to get that transformation. This means we can apply a plethora of computer vision techniques segmentation geometry detection to understand this fiducial plus's estimate on the ground plane world in the physical world and then we complete the storage mission. On the right hand side you'll see the vehicle detecting with its front camera the fiducial plus to perform an alignment.

³⁷ *Id.* at 5:17, 7:02, 7:30.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation. This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.
d) obtaining direction information of the photographed location recognition tag; and	The Accused Instrumentalities obtain direction information of the photographed location recognition tag. For example, Kiva uses a software system to tie distance information, location information and direction information together.³⁸

³⁸ See KAIFI0006779 (Ben Einstein, *Meet the drone that already delivers your packages, Kiva robot teardown* (Feb. 1, 2016), <https://robohub.org/meet-the-drone-that-already-delivers-your-packages-kiva-robot-teardown/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	The system Kiva developed comprises on 5 key components: • Custom designed Kiva shelves ("pods") that are mobile and highly flexible • A grid of 2D QR codes implanted on the floor (known as "fiducials") • An intelligent pack station decked out with scales, lasers, and sensors • Herculean orange robots that swiftly lift and move the pods around the floor • And most important of all: a complex and robust software system tying everything together While all these components are amazing in their own right (and necessary for the system to function), this post focuses on the bright orange bots droning around the warehouse floor. For example, Kiva's control system determine how far off their bodies are from the center of the stickers.³⁹ Their innovation was to put bar-code stickers on the floor and equip the robots with cameras to read them. As the robots move, they read the encoded information to learn their coordinates in the warehouse. At the same time, the robots' control systems determine how far off their bodies are from the center of the stickers. If, for instance, a robot is a bit off to the right, the control system nudges it to the left.

³⁹ See KAIFI0004451 (*Kiva Systems: Three Engineers, Hundreds of Robots, One Warehouse*, <https://spectrum.ieee.org/three-engineers-hundreds-of-robots-one-warehouse>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	For example, Proteus uses custom robot control system software.⁴⁰ SENSORS Vision system with cameras and high-precision lidar for perception and navigation, including maneuvering underneath carts and reading fiducials on the ground. Upward and downward-facing cameras to read barcodes. Other collision-avoidance sensors. ACTUATORS Motors to drive wheels and power lifting mechanism. COMPUTE On-board computer and control boards. Colored lights and LED "eyes" for human-robot interaction. SOFTWARE Custom robot control system. Integrated with fleet management software stack and Amazon's warehouse management systems. For example, Amazon's AMRs use Fiducial Plus tags to obtain direction information of the photographed location recognition tag.⁴¹

⁴⁰ See KAIFI0006967 (*Proteus*, <https://robotsguide.com/robots/proteus>).

⁴¹ See KAIFI0007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	STORAGE CELL DETECTION Local perception target – Fiducial Plus • Observable characteristic length • Soft modification Mapping: image plane → ground plane According to Amazon:⁴² Transcript: next we'll talk about this new fiducial plus which is a custom-made ground target which allows us to detect storage cells and do precision alignment. On the right hand side you'll see the vehicle detecting with its front camera the fiducial plus to perform an alignment. On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation. This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the

⁴² *Id.* at 5:17, 7:30.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.
e) calculating a mobile terminal location by using the distance information measured in b), the location information obtained in c), and the direction information obtained in d).	The Accused Instrumentalities calculate a mobile terminal location by using the distance information measured in b), the location information obtained in c), and the direction information obtained in d) For example, see evidence of Amazon’s infringement in 1(b), 1(d) and 1(e) above. For example, Kiva uses a software system to tie distance information, location information and direction information together.⁴³

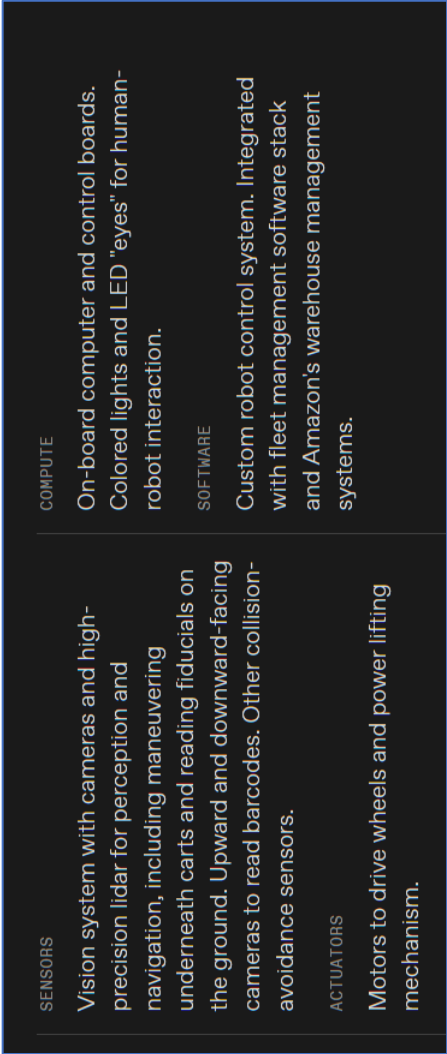
⁴³ See KAIFI0006779 (Ben Einstein, *Meet the drone that already delivers your packages, Kiva robot teardown* (Feb. 1, 2016), <https://robohub.org/meet-the-drone-that-already-delivers-your-packages-kiva-robot-teardown/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	The system Kiva developed comprises on 5 key components: • Custom designed Kiva shelves ("pods") that are mobile and highly flexible • A grid of 2D QR codes implanted on the floor (known as "fiducials") • An intelligent pack station decked out with scales, lasers, and sensors • Herculean orange robots that swiftly lift and move the pods around the floor • And most important of all: a complex and robust software system tying everything together While all these components are amazing in their own right (and necessary for the system to function), this post focuses on the bright orange bots droning around the warehouse floor. For example, Kiva's control system determine how far off their bodies are from the center of the stickers.⁴⁴ Their innovation was to put bar-code stickers on the floor and equip the robots with cameras to read them. As the robots move, they read the encoded information to learn their coordinates in the warehouse. At the same time, the robots' control systems determine how far off their bodies are from the center of the stickers. If, for instance, a robot is a bit off to the right, the control system nudges it to the left.

⁴⁴ See KAIFI0004451 (Kiva Systems: *Three Engineers, Hundreds of Robots, One Warehouse*, <https://spectrum.ieee.org/three-engineers-hundreds-of-robots-one-warehouse>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
For example, Proteus uses custom robot control system software.⁴⁵	 The diagram illustrates the components of the Proteus robot system, organized into three main functional areas: SENSORS: Vision system with cameras and high-precision lidar for perception and navigation, including maneuvering underneath carts and reading fiducials on the ground. Upward and downward-facing cameras to read barcodes. Other collision-avoidance sensors. ACTUATORS: Motors to drive wheels and power lifting mechanism. COMPUTE SOFTWARE: On-board computer and control boards. Colored lights and LED "eyes" for human-robot interaction. Custom robot control system. Integrated with fleet management software stack and Amazon's warehouse management systems. For example, Amazon's AMRs use Fiducial Plus tags.⁴⁶

⁴⁵ See KAIFI0006967 (*Proteus*, <https://robotsguide.com/robots/proteus>).

⁴⁶ See KAIFI0007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	STORAGE CELL DETECTION Local perception target – Fiducial Plus • Observable characteristic length • Soft modification Mapping: image plane → ground plane  For example, according to Amazon:⁴⁷ So now you can see on the right-hand side we have a nice one-to-one mapping from the camera plane down to the ground plane. We use the camera's intrinsic and extra index calibrated in order to get that transformation. This means we can apply a plethora of computer vision techniques segmentation geometry detection to understand this fiducial plus's estimate on the ground plane world in the physical world and then we complete the storage mission. On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation.

⁴⁷ *Id.* at 7:02.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 1	Accused Instrumentality(ies)
	This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.

Claim 2 of the '001 Patent

Claim 2	Accused Instrumentality(ies)
The method of claim 1, wherein the direction information obtained in d) is offset information of an offset state of the location recognition tag based on the mobile terminal, and the offset information is obtained by analyzing a photographing angle of the photographed location recognition tag.	In the Accused Instrumentalities, the direction information of the photographed location recognition tag is offset information of an offset state of the location recognition tag based on the mobile terminal, and the offset information is obtained by analyzing a photographing angle of the photographed location recognition tag. For example, see evidence of Amazon's infringement in 1(d) above. For example, Kiva uses control systems to determine how far off its body is from the center of the stickers.⁴⁸

⁴⁸ See KAIFI0004451 (*Kiva Systems: Three Engineers, Hundreds of Robots, One Warehouse*, <https://spectrum.ieee.org/three-engineers-hundreds-of-robots-one-warehouse>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 2	Accused Instrumentality(ies)
	Their innovation was to put bar-code stickers on the floor and equip the robots with cameras to read them. As the robots move, they read the encoded information to learn their coordinates in the warehouse. At the same time, the robots' control systems determine how far off their bodies are from the center of the stickers. If, for instance, a robot is a bit off to the right, the control system nudges it to the left. The control system also reports its readings to the computer cluster to share that information with other robots. This distributed-control approach improves their navigation capabilities. Say a robot sees certain stickers off to the left. Instead of simply correcting its course by turning to the right, the robot first checks what other robots see—what the “wisdom of the crowd” is. If most of them see centered stickers, the robot figures that the stickers are in the right place and that the shift in position is due to inherent imperfections with its own hardware—its camera may be off center or its wheels misaligned. The robot then adjusts its own control parameters to navigate more accurately. In fact, the machines drive so meticulously that their rubber wheels leave precisely aligned tracks on the warehouse floor. For example, Amazon’s AMRs use Fiducial Plus tags to obtain direction information of the photographed location recognition tag.⁴⁹

⁴⁹ See KAIF10007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 2	Accused Instrumentality(ies)
	According to Amazon.⁵⁰ Transcript: next we'll talk about this new fiducial plus which is a custom-made ground target which allows us to detect storage cells and do precision alignment. We design instead this fiducial plus it's the same precision fiducials that we know and love from our grid-based systems wrapped with a larger green square which is visible from the front camera so now it has a nice characteristic length it's large enough that we can understand its positional orientation. On the right hand side you'll see the vehicle detecting with its front camera the fiducial plus to perform an alignment.

⁵⁰ *Id.* at 5:17, 6:41; 7:30.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 2	Accused Instrumentality(ies)
	On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation. This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.

Claim 3 of the '001 Patent

Claim 3	Accused Instrumentality(ies)
The method of claim 1, wherein the distance information in b) is measured by the camera when an auto focusing operation of the camera is performed.	In the Accused Instrumentalities, the distance information in b) is measured by the camera when an auto focusing operation of the camera is performed. For example, Amazon's AMRs use the use the camera's intrinsics.⁵¹

⁵¹ See KAIFI0007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 3	Accused Instrumentality(ies)
	STORAGE CELL DETECTION Local perception target – Fiducial Plus • Observable characteristic length • Soft modification Mapping: image plane → ground plane For example, according to Amazon:⁵² So now you can see on the right-hand side we have a nice one-to-one mapping from the camera plane down to the ground plane. We use the camera's intrinsic and extra index calibrated in order to get that transformation. This means we can apply a plethora of computer vision techniques segmentation geometry detection to understand this fiducial plus's estimate on the ground plane world in the physical world and then we complete the storage mission. Discovery and investigation from Amazon will identify the camera equipment and distance measurement technologies used in Amazon's AMRs and reveal additional information concerning Amazon's infringement.

⁵² *Id.* at 7:02.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 3	Accused Instrumentality(ies)
	On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation. This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.

Claim 5 of the '001 Patent

Claim 5	Accused Instrumentality(ies)
The method of claim 1, wherein the location recognition tags are arranged so that a desired precision for using the location recognition tags at a predetermined physical area may be achieved, and the location recognition tags are formed as one-dimensional or two-dimensional barcode types. For example, Kiwa navigates the warehouse by pointing cameras at the floor that read two-dimensional bar-coded stickers laid out by hand 1 meter from each other, in a grid.⁵³	

⁵³ See KAIFI0004451 (*Kiva Systems: Three Engineers, Hundreds of Robots, One Warehouse*, <https://spectrum.ieee.org/three-engineers-hundreds-of-robots-one-warehouse>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 5	Accused Instrumentality(ies)
dimensional or two-dimensional barcode types.	For example, see evidence of Amazon's infringement in 1(b) - 1(e) above. On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation. This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.

Claim 7 of the '001 Patent

Claim 7	Accused Instrumentality(ies)
The method of any one of claim 1 to claim 6, wherein the location recognition tag stores location information of one among an absolute location coordinate and a logic location coordinate.	In the Accused Instrumentalities, the location recognition tag stores location information of one among an absolute location coordinate and a logic location coordinate. The Accused Instrumentalities comprise an image analyzing unit. The image analyzing unit is configured to analyze an image of the location recognition tag processed by the image photographing unit. The image analyzing unit is configured to obtain corresponding location information and direction information of the location recognition tag.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 7	Accused Instrumentality(ies)
	For example, Kiva comprises cameras that read two-dimensional bar-coded stickers laid out in a grid.⁵⁴ the system. The robots, he explains, navigate the warehouse by pointing cameras at the floor that read two-dimensional bar-coded stickers laid out by hand 1 meter from each other, in a grid. The robots relay the encoded information wirelessly to a computer cluster that functions both as a dispatcher and a traffic controller. It instructs, for instance, robot No. 1051 to bring rack No. 308 to worker No. 12—without colliding with robot No. 1433, which is crossing its path. For example, Kiva uses a distributed-control approach.⁵⁵

⁵⁴ See KAIFI0004434 (*Squat and Smart* (July 2008)), https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=23#/p/22).

⁵⁵ See *id.*

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

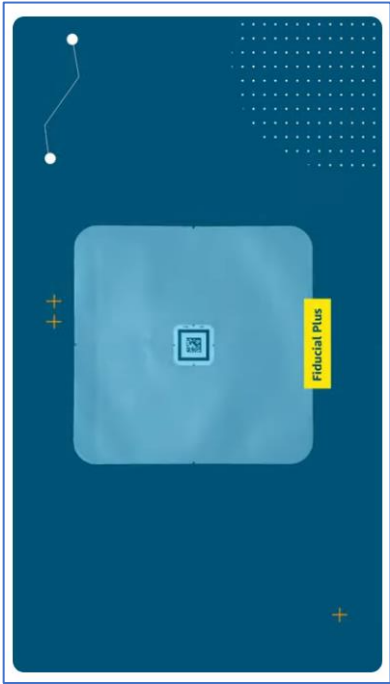
Claim 7	Accused Instrumentality(ies)
	The control system also reports its readings to the computer cluster to share that information with other robots. This distributed-control approach improves their navigation capabilities. Say a robot sees certain stickers off to the left. Instead of simply correcting its course by turning to the right, the robot first checks what other robots see—what the “wisdom of the crowd” is. If most of them see cen- tered stickers, the robot figures that the stickers are in the right place and that the shift in position is due to inherent imperfections with its own hardware—its camera may be off center or its wheels misaligned. The robot then adjusts its own control parameters to navigate more accurately. In fact, the machines drive so meticulously that their rubber wheels leave precisely aligned tracks on the warehouse floor.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 7	Accused Instrumentality(ies)
	The greatest advantage of this approach is that the robots are mechanically simpler, and therefore cheaper. Rather than equipping the robots with expensive, high-precision parts to ensure they drive in straight lines, Kiva lets the control software take care of the variations and imperfections in the hardware components. "We don't have to buy the best motors, the best gear boxes to make the robots reliable," says Dennis Polic, one of the electrical engineers. "The control system takes care of that." For example, Kiva comprises an image processing board.⁵⁶

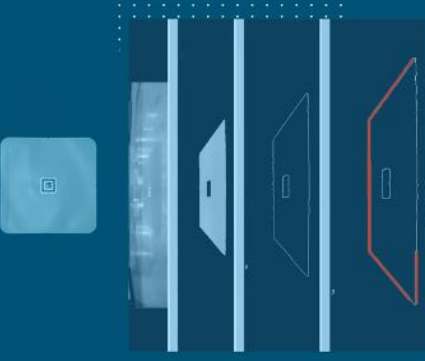
⁵⁶ See KAIFI0006779 (Ben Einstein, *Meet the drone that already delivers your packages, Kiva robot teardown* (Feb. 1, 2016), <https://robohub.org/meet-the-drone-that-already-delivers-your-packages-kiva-robot-teardown/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

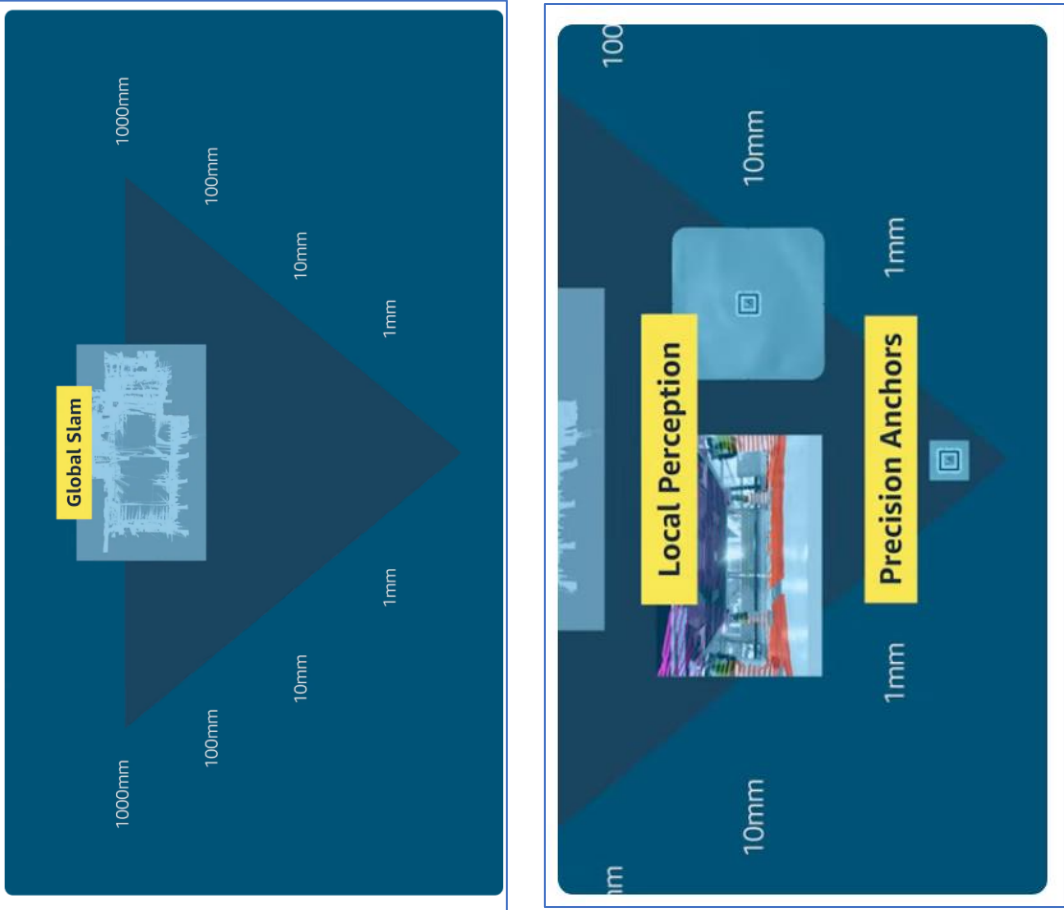
Claim 7	Accused Instrumentality(ies)
	Tucked inside the lifter mechanism is one of the key enablers of the Kiva system: a dual-camera imaging module. One camera looks down at the ground to recognize 2D barcodes on the warehouse floor. The other looks upwards at the bottom of every pod. Each has 6 on-board red LEDs for illumination and like the rest of the robot, everything is custom designed. Sandwiched between the two imagers is an image processing board sporting an ADI ADSP-BF548 Blackfin multimedia processor which is doing the Datamatrix detection and relaying results via high-speed serial. For example, Proteus comprises cameras that read bar-codes.⁵⁷ 

⁵⁷ See KAIF10007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

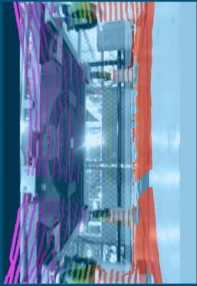
Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 7	Accused Instrumentality(ies)
	STORAGE CELL DETECTION Local perception target – Fiducial Plus • Observable characteristic length • Soft modification Mapping: image plane ↔ ground plane  PUTTING IT TOGETHER WITH PROTEUS  adjustments are performed with upward and downward-facing cameras

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 7	Accused Instrumentality(ies)
	 The diagram consists of two parts, each showing a blue background with a dark blue triangle. The triangle's vertices are labeled with accuracy values: 1000mm at the top, 100mm at the bottom-left, and 1mm at the bottom-right. The left part is labeled 'Global Slam' and shows a 3D point cloud of a building. The right part is labeled 'Local Perception' and 'Precision Anchors' and shows a 3D point cloud of a street scene with a car. The right part also includes a small inset showing a 2D image of a car with a 1mm accuracy label.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 7	Accused Instrumentality(ies)
	GOCART DETECTION • Local perception target – GoCart itself • Lidar clustering – known geometry  For example, Proteus uses a distributed-control approach.⁵⁸ <i>Proteus autonomously moves through our facilities using advanced safety, perception, and navigation technology developed by Amazon. The robot was built to be automatically directed to perform its work and move around employees—meaning it has no need to be confined to restricted areas. It can operate in a manner that augments simple, safe interaction between technology and people—opening up a broader range of possible uses to help our employees—such as the lifting and movement of GoCarts, the nonautomated, wheeled transports used to move packages through our facilities.</i>

⁵⁸ See KAIF10001260 (Evan Ackerman, *Amazon Shows Off Impressive New Warehouse Robots > It's a lot of progress over just one year* (Jun. 23, 2022), <https://spectrum.ieee.org/amazon-warehouse-robots>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 7	Accused Instrumentality(ies)
	For example, Proteus utilizes an on-board computer and control boards.⁵⁹ SENSORS Vision system with cameras and high-precision lidar for perception and navigation, including maneuvering underneath carts and reading fiducials on the ground. Upward and downward-facing cameras to read barcodes. Other collision-avoidance sensors. ACTUATORS Motors to drive wheels and power lifting mechanism. COMPUTE On-board computer and control boards. Colored lights and LED "eyes" for human-robot interaction. SOFTWARE Custom robot control system. Integrated with fleet management software stack and Amazon's warehouse management systems. For example, Amazon's AMRs analyze Fiducial Plus tags to obtain location information corresponding to those tags.⁶⁰

⁵⁹ See KAIFI0006967 (*Proteus*, <https://robotsguide.com/robots/proteus>).

⁶⁰ See KAIFI0007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 7	Accused Instrumentality(ies)
	According to Amazon:⁶¹ Transcript: next we'll talk about this new fiducial plus which is a custom-made ground target which allows us to detect storage cells and do precision alignment. So now you can see on the right-hand side we have a nice one-to-one mapping from the camera plane down to the ground plane. We use the camera's intrinsic and extra index calibrated in order to get that transformation. This means we can apply a plethora of computer vision techniques segmentation geometry detection to understand this fiducial plus's estimate on the ground plane world in the physical world and then we complete the storage mission. On the right hand side you'll see the vehicle detecting with its front camera the fiducial plus to perform an alignment.

⁶¹ *Id.* at 5:17, 7:02, 7:30.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 7	Accused Instrumentality(ies)
	On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation. This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.

Claim 8 of the '001 Patent

Claim 8	Accused Instrumentality(ies)
A location recognition device for recognizing a location by using a built-in camera, the location recognition device comprising:	Amazon deploys an automation system using location recognition devices at its facilities. For example, Amazon deploys autonomous mobile robots (AMR).⁶²

⁶² See KAIFI0001125 (Brianna Wessling, *A decade after acquiring Kiva, Amazon unveils its first AMR* (Jun. 22, 2022), <https://www.therobotreport.com/a-decade-after-acquiring-kiva-amazon-unveils-its-first-amr/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	Amazon first entered the mobile robot space in 2012, when it acquired Kiva Systems for \$775 million. Kiva offered automated guided vehicles (AGVs) that could navigate a warehouse using a series of computerized barcode stickers on the floor. Now, a decade later, Amazon has announced its first fully autonomous mobile robot (AMR). Proteus is an AMR with a similar design to the Kiva robots that have been at work in Amazon's warehouses for years. Proteus can slide under Amazon's GoCarts, pick them up and move them across the warehouse to employees or other robotic cells, reducing the amount of walking Amazon workers need to retrieve items.  For example, according to Amazon, it is using at least 750,000 AMRs.⁶³

⁶³ See KAIF10002113 (Joseph Quinlivan, *How Amazon deploys collaborative robots in its operations to benefit employees and customers* (Jun. 26, 2023), <https://www.aboutamazon.com/news/operations/how-amazon-deploys-robots-in-its-operations-facilities>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	 Principal Tech Program Manager, Proteus Lead Nikolai Taylor stands next to Proteus, an Amazon robot. 750,000 Amazon robots are doing the heavy lifting for our employees so they can deliver for customers. With the latest in AI, our technology makes our sites safer and enables employee upskilling. For over a decade, we've pioneered technology and robotics in our operations, driving innovation and growth that directly benefits our employees and customers. The rate of our innovation has only accelerated, thanks in large part to unprecedented advancements in AI. Throughout the years, we've consistently focused on building safe, practical, and dependable technology and robotics that optimize our supply chain. We're particularly excited about some of the latest collaborative robotics we've developed and announced over the last year. Using the latest in computer vision, and machine learning our newest industrial robots can operate alongside humans safely and include our first autonomous mobile robot, Proteus; new robotic handling systems, specifically Cardinal and Sparrow; and a new approach to inventory management, called Containerized Storage, which uses robots to deliver products to employees in a more ergonomically friendly manner.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	For example, according to Amazon:⁶⁴  Proteus Robot Photo: Amazon Amazon has unveiled two new fully autonomous mobile warehouse robots, Proteus and Cardinal. The robots are designed to help Amazon employees move products more efficiently and safely in its fulfillment centers. But what do they look like and how are they expected to help? First, we have Proteus, a large, rectangular robot that can carry up to 5,000 pounds of cargo. It is designed to move carts of products around the warehouse floor, freeing up employees to focus on other tasks. Proteus is powered by a battery and can travel up to 10 miles per hour.

⁶⁴ See KAIFI0001291 (Brian Crum, *Amazon Unveils New Fully Autonomous Mobile Warehouse Robots* (Jul. 6, 2023), <https://retailwire.com/discussion/amazon-unveils-new-fully-autonomous-mobile-warehouse-robots/>).

Appendix E Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	Both Proteus and Cardinal are designed to work safely alongside human employees. They are equipped with sensors that allow them to detect and avoid obstacles, and they have a slow-moving mode that allows employees to interact with them safely. For example, Amazon has used Kiva.⁶⁵  SQUAT AND SMART Kiva's robots have more than 900 parts, from off-the-shelf DC motors to custom-made ball screws. Here's how the robots' Kiva systems work. © Amazon.com, Inc. 2015 NAVIGATION SYSTEM A camera facing upward reads bar codes placed under inventory racks. The camera also reads bar codes located at the bottom of the robot's view bar codes. This information is combined with readings from other navigation sensors, such as accelerometers, gyroscopes, and rate gyros. POWER SYSTEM Four internal batteries power the robot's navigation and control electronics. When batteries run low, the robot's navigation system directs it to a charging station. DRIVING SYSTEM Two sets of omni-wheels, each with a motor, drive the robot. The robot's navigation system directs the robot's movement, moving the robot at 1.5 meters per second. COLLISION-DETECTION SYSTEM Infrared sensors and bumpers stop the robot if people or objects get in its way. LIFTING MECHANISM A large screw turns to raise racks of inventory. As the screw turns, the wheels make the robot rotate around. At the same time, the wheels make the robot rotate to keep the rack motionless.

⁶⁵ See KAIFI0004434 (*Squat and Smart* (July 2008), https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=23#/p/22).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	For example, Amazon has used Proteus.⁶⁶

⁶⁶ See KAIF10001098 (*10 years of Amazon robotics: how robots help sort packages, move product, and improve safety* (Jun. 21, 2022), <https://www.aboutamazon.com/news/operations/10-years-of-amazon-robotics-how-robots-help-sort-packages-move-product-and-improve-safety>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	Proteus is our first fully autonomous mobile robot. Historically, it's been difficult to safely incorporate robotics in the same physical space as people. We believe Proteus will change that while remaining smart, safe, and collaborative. Proteus autonomously moves through our facilities using advanced safety, perception, and navigation technology developed by Amazon. The robot was built to be automatically directed to perform its work and move around employees—meaning it has no need to be confined to restricted areas. It can operate in a manner that augments simple, safe interaction between technology and people—opening up a broader range of possible uses to help our employees—such as the lifting and movement of GoCarts, the non-automated, wheeled transports used to move packages through our facilities. Proteus will initially be deployed in the outbound GoCart handling areas in our fulfillment centers and sort centers. Our vision is to automate GoCart handling throughout the network, which will help reduce the need for people to manually move heavy objects through our facility and instead let them focus on more rewarding work. Proteus has a similar design to Kiva.⁶⁷

⁶⁷ See KAIFI0001125 (Brianna Wessling, *A decade after acquiring Kiva, Amazon unveils its first AMR* (Jun. 22, 2022), <https://www.therobotreport.com/a-decade-after-acquiring-kiva-amazon-unveils-its-first-amr/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	Amazon first entered the mobile robot space in 2012, when it acquired Kiva Systems for \$775 million. Kiva offered automated guided vehicles (AGVs) that could navigate a warehouse using a series of computerized barcode stickers on the floor. Now, a decade later, Amazon has announced its first fully autonomous mobile robot (AMR), Proteus. Proteus is an AMR with a similar design to the Kiva robots that have been at work in Amazon's warehouses for years. Proteus can slide under Amazon's GoCarts, pick them up and move them across the warehouse to employees or other robotic cells, reducing the amount of walking Amazon workers need to retrieve items. For example, Amazon has used Sequoia.⁶⁸ 

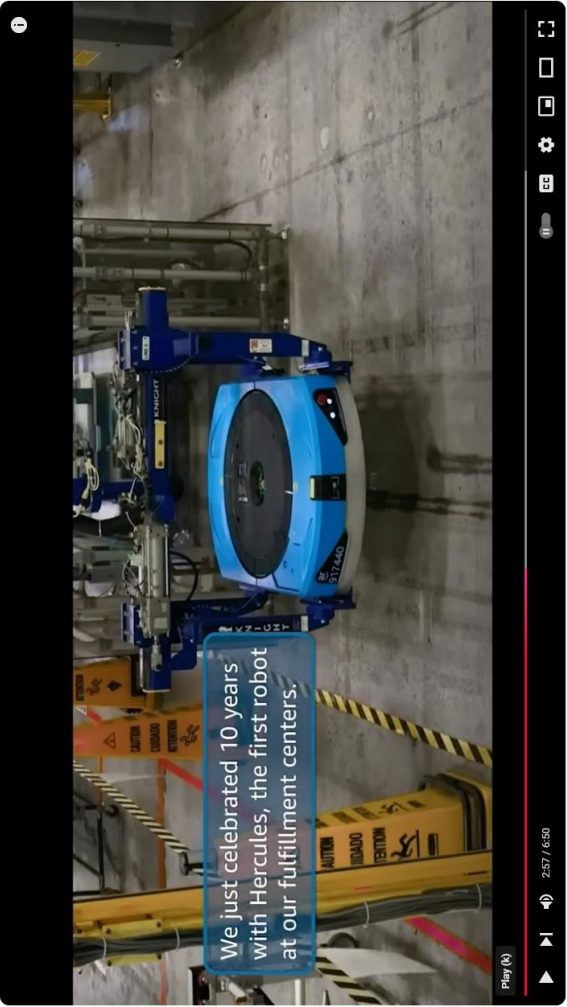
⁶⁸ See KAIFI0001204 (Scott Dresser, *Amazon announces 2 new ways it's using robots to assist employees and deliver for customers* (Oct. 18, 2023), <https://www.aboutamazon.com/news/operations/amazon-introduces-new-robotics-solutions>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	With all of these efforts underway, it makes us particularly proud to share that we have just launched a new robotic system in time to help fulfill customer orders for holiday shopping this year. Sequoia is the name of this new technology, and it's now operating at one of our fulfillment centers in Houston, Texas. Building off a series of research and development efforts, Sequoia integrates multiple robot systems to containerize our inventory into totes, bringing together mobile robots, gantry systems, robotic arms, and a new ergonomic employee workstation. The system works by having mobile robots transport containerized inventory directly to a gantry, a tall frame with a platform supporting equipment that can either restock totes or send them to an employee to pick out inventory that customers have ordered. These totes come to employees at a newly-designed ergonomic workstation that allows them to do all their work in their power zone, between mid-thigh and mid-chest height. With this system, employees will no longer have to regularly reach above their heads or squat down to pick customer orders, supporting our efforts to reduce the risk of injuries. For example, Amazon has used Hercules.⁶⁹

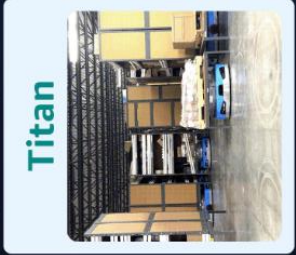
⁶⁹ See KAIFI0007813 (*Introducing the Full Amazon Robot Line Up* (May 8, 2023), <https://www.youtube.com/watch?v=7SvTdW4OLUQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	 For example, Amazon has used Titan.⁷⁰

⁷⁰ See, KAIFI0007703 (Meet the 8 robots powering your Amazon package deliveries, <https://www.aboutamazon.com/news/operations/amazon-robotics-robots-fulfillment-center>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	3. Titan  Titan Job: Transports large and bulky items to employees Capacity: Can lift up to 2,500 pounds Launched in: San Antonio, Texas, in 2017 Size: 52.1 in. by 36.6 in. by 9.47 in., and weighs around 510 pounds, or slightly smaller than a baby grand piano without legs Similar to Hercules, Titan is another drive unit that brings items from across Amazon's fulfillment centers directly to employees as they assemble customer orders. What's special about <u>Titan</u> is that it can lift twice as much as Hercules, meaning it focuses on larger and/or bulkier items like small household appliances or pallets of food. For example, Amazon has used Pegasus and Xanthus (a/k/a X-bot).⁷¹⁷²

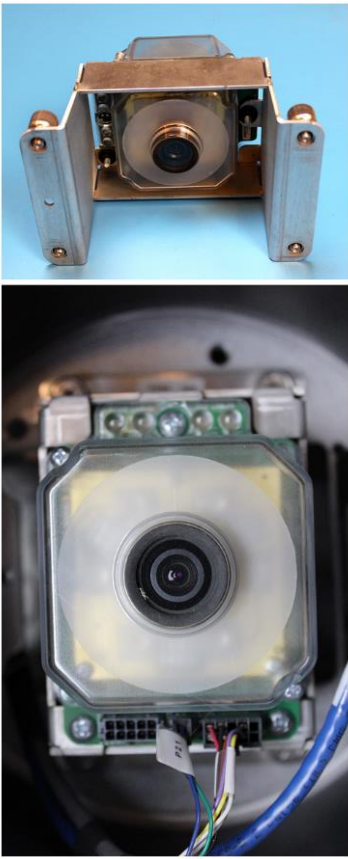
⁷¹ See KAIF10007781 (*Amazon's tiny robot drives do the heavy lifting*, <https://www.amazon.science/latest-news/amazon-robotics-autonomous-drive-units-hercules-pegasus-xanthus-xbot>).

⁷² See KAIF10007769 (*Amazon Uses 800 Robots to Run This Warehouse*, <https://spectrum.ieee.org/amazon-introduces-two-new-warehouse-robots>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	  Xanthus, one of two new robots Amazon unveiled today, can be equipped with different modules like conveyor belts and stacks of bins to perform a wide variety of tasks. IMAGE: AMAZON

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
[a] an image photographing unit for photographing a plurality of location recognition tags that are arranged in a predetermined physical area and respectively store location recognition information, and for performing a digital image process;	The Accused Instrumentalities comprise an image photographing unit. The image photographing unit is configured to photograph a plurality of location recognition tags. The location recognition tags are arranged in a predetermined physical area and respectively store location recognition information. The image photographing unit is configured to perform a digital image process. For example, Kiva comprises a dual-camera imaging module.⁷³  On the left: top-facing imager inside the lifter ball screw. On the right: bottom-facing imager once imaging unit is removed.

⁷³ See KAIFI0006779 (Ben Einstein, *Meet the drone that already delivers your packages, Kiva robot teardown* (Feb. 1, 2016), <https://robohub.org/meet-the-drone-that-already-delivers-your-packages-kiva-robot-teardown/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	Tucked inside the lifter mechanism is one of the key enablers of the Kiva system: a dual-camera imaging module. One camera looks down at the ground to recognize 2D barcodes on the warehouse floor. The other looks upwards at the bottom of every pod. Each has 6 on-board red LEDs for illumination and like the rest of the robot, everything is custom designed. Sandwiched between the two imagers is an image processing board sporting an <u>ADI ADSP-BF548</u> Blackfin multimedia processor which is doing the Datamatrix detection and relaying results via high-speed serial. For example, Kiva comprises a navigation system.⁷⁴

⁷⁴ See KAIFI0004434 (*Squat and Smart* (July 2008), https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=23#/p/22).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	 SQUAT AND SMART Kiva's robots have more than 900 parts, from off-the-shelf dc motors to custom-made ball screws. Here's how the robots' main systems work. PHOTOS: KUSHAL SALLAMER NAVIGATION SYSTEM A camera facing upward reads bar codes placed under inventory racks to identify them. Another camera located at the bottom of the robot views bar codes on the floor. This location information is combined with readings from other navigation sensors, such as encoders, accelerometers, and rate gyros. POWER SYSTEM Four lead-acid batteries power the motors and onboard electronics. When batteries run low, the robot automatically drives to a charging station. DRIVING SYSTEM Two brushless dc motors control independent neoprene rubber wheels, moving the robot at 1.3 meters per second. LIFTING MECHANISM A large screw turns to raise racks of inventory 5 centimeters from the ground. At the same time, the wheels make the robot rotate in the opposite direction to keep the rack motionless. COLLISION-DETECTION SYSTEM Infrared sensors and touch-sensitive bumpers stop the robot if people or objects get in its way. For example, Kiva comprises cameras that read two-dimensional bar-coded stickers laid out in a grid.⁷⁵

⁷⁵ See *id.*

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	the system. The robots, he explains, navigate the warehouse by pointing cameras at the floor that read two-dimensional bar-coded stickers laid out by hand 1 meter from each other, in a grid. The robots relay the encoded information wirelessly to a computer cluster that functions both as a dispatcher and a traffic controller. It instructs, for instance, robot No. 1051 to bring rack No. 308 to worker No. 12—without colliding with robot No. 1433, which is crossing its path. For example, Kiva uses a grid of 2D QR codes.⁷⁶

⁷⁶ See KAIFI0006779 (Ben Einstein, *Meet the drone that already delivers your packages, Kiva robot teardown* (Feb. 1, 2016), <https://robohub.org/meet-the-drone-that-already-delivers-your-packages-kiva-robot-teardown/>).

Appendix E

Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	The system Kiiva developed comprises on 5 key components: • Custom designed Kiiva shelves ("pods") that are mobile and highly flexible • A grid of 2D QR codes implanted on the floor (known as "fiducials") • An intelligent pack station decked out with scales, lasers, and sensors • Herculean orange robots that swiftly lift and move the pods around the floor • And most important of all: a complex and robust software system tying everything together While all these components are amazing in their own right (and necessary for the system to function), this post focuses on the bright orange bots droning around the warehouse floor. For example, Kiiva uses a distributed-control approach.⁷⁷ The control system also reports its readings to the computer cluster to share that information with other robots. This distributed-control approach improves their navigation capabilities. Say a robot sees certain stickers off to the left. Instead of simply correcting its course by turning to the right, the robot first checks what other robots see—what the "wisdom of the crowd" is. If most of them see cen-

⁷⁷ See KAIFI0004434 (*Squat and Smart* (July 2008), https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=23#/p/22).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

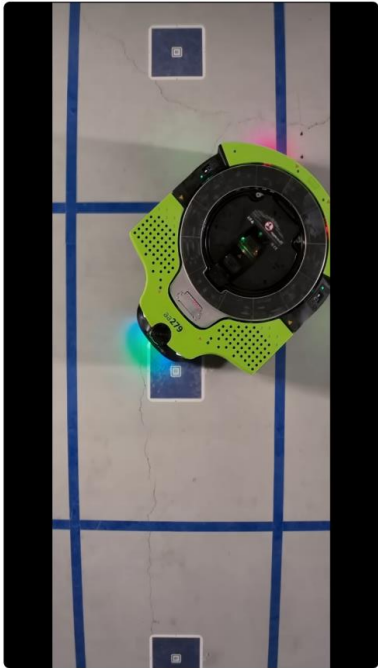
Claim 8	Accused Instrumentality(ies)
	tered stickers, the robot figures that the stickers are in the right place and that the shift in position is due to inherent imperfections with its own hardware—its camera may be off center or its wheels misaligned. The robot then adjusts its own control parameters to navigate more accurately. In fact, the machines drive so meticulously that their rubber wheels leave precisely aligned tracks on the warehouse floor. The greatest advantage of this approach is that the robots are mechanically simpler, and therefore cheaper. Rather than equipping the robots with expensive, high-precision parts to ensure they drive in straight lines, Kiva lets the control software take care of the variations and imperfections in the hardware components. “We don’t have to buy the best motors, the best gear boxes to make the robots reliable,” says Dennis Polic, one of the electrical engineers. “The control system takes care of that.”

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	For example, Proteus utilizes a Simultaneous Localization and Mapping (“SLAM”) system.⁷⁸ What is an AMR? An Autonomous Mobile Robot, or AMR, is a vehicle that uses on-board sensors and processors to autonomously move materials without the need for physical guides or markers. It learns its environment, remembers its location, and dynamically plans its own path from one waypoint (a location or destination within the environment) to another. Features of an AMR: - Navigation: Using technology such as LIDAR sensors & Simultaneous Localization and Mapping (SLAM), an AMR will determine the best route between waypoints - Deployment: This can vary, but great AMRs can be unboxed and put to work in less than 15 minutes - Operational Flexibility: An AMR will dynamically plan the shortest path based on current conditions and requirements, if the work changes from one day to the next, the AMR's route will change with it - Responsiveness: AMRs will automatically sense and avoid obstacles and blocked paths to find the best route to its next waypoint

⁷⁸ See KAIFI0006774 (*Meet Amazon's First Fully Autonomous Mobile Robot*, <https://www.warehouseautomation.ca/news-notes-1/2022/8/8/meet-amazons-first-fully-autonomous-mobile-robot>).

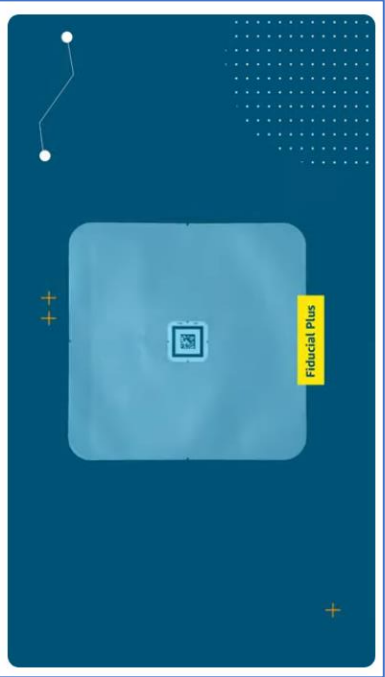
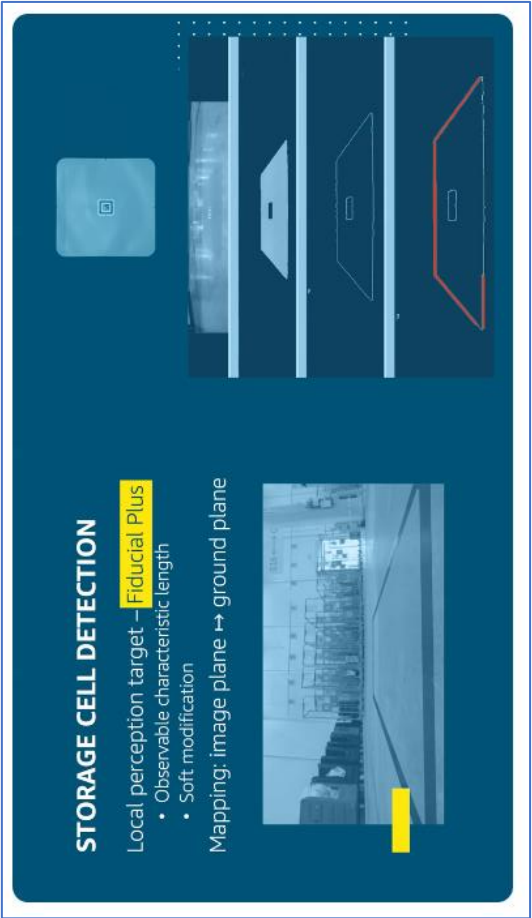
Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	As a further example, Proteus' cameras read barcodes.⁷⁹  According to Amazon, Proteus is comprised of multiple cameras that read bar-codes.⁸⁰

⁷⁹ See KAIFI0007813 (*Introducing the Full Amazon Robot Line Up* (May 8, 2023), <https://www.youtube.com/watch?v=7SvTdW4OLUQ>).

⁸⁰ See KAIFI0007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

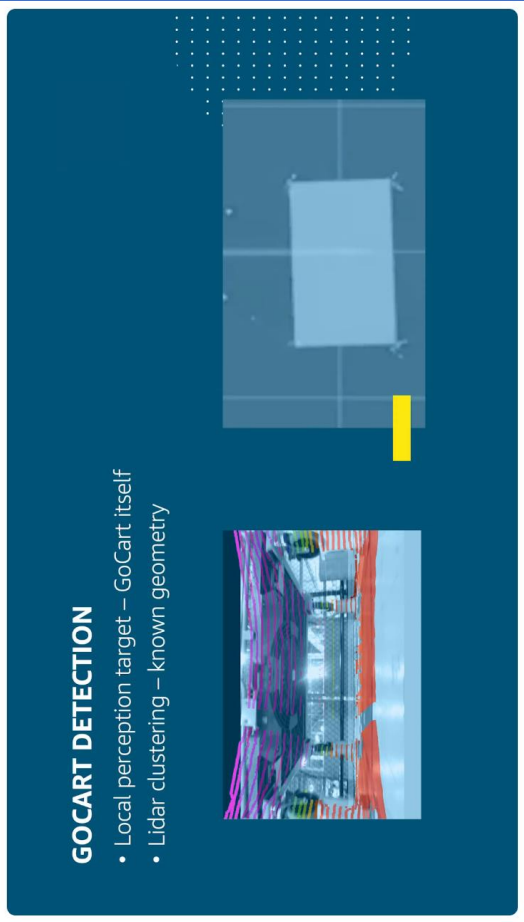
Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	 

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	 

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	GOCART DETECTION • Local perception target – GoCart itself • Lidar clustering – known geometry  For example, Amazon’s AMRs photograph Fiducial Plus tags.⁸¹

⁸¹ *Id.*

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	 STORAGE CELL DETECTION Local perception target – Fiducial Plus • Observable characteristic length • Soft modification Mapping: image plane ↔ ground plane For example, Hercules uses a camera to read markers.⁸² Hercules itself is a fourth-generation drive designed to navigate structured fields, floors that contain a grid of encoded markers. By reading the markers with its downward facing camera, it can find its position and the location of any pod. For example, Titan uses equivalent technologies.⁸³

⁸² See KAIFI0001072 (4 cool facts about Hercules, the small-but-mighty robot in Amazon's fulfillment centers (September 7, 2023), <https://www.aboutamazon.com/news/operations/amazon-hercules-robot>).

⁸³ See KAIFI0007697 (Introducing Titan, Amazon's new mobile robot that can lift up to 2,500 pounds (November 14, 2023), <https://www.aboutamazon.com/news/operations/amazon-unveils-titan-fulfillment-center-robot>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	Titan integrates several technologies from previous mobile robots, including the battery and charging management solution from Hercules, and the computer vision, obstacle detection, and user control systems from the Xanthus mobile robot. Titan also uses hardware components from Proteus to manage its operating system as it plans, executes, and interfaces with other technologies within the facility. On information and belief, each of Amazon’s AMRs rely on equivalent technologies in relation to their use of location recognition tags and the limitations set forth in this claim chart.⁸⁴ Thus, the evidence in this chart applies equally to all AMR iterations identified in this chart. Every day at Amazon fulfillment centers, more than half a million robots assist with stocking inventory, filling orders, and sorting packages for delivery. These robots follow directions provided by cloud-based algorithms and navigate along a grid of encoded markers. Virtual and physical barriers restrict their interactions with people, as well as where they can and cannot go. For example, according to Amazon.⁸⁵

⁸⁴ See KAIF10007714 (*The quest to deploy autonomous robots within Amazon fulfillment centers* (October 24, 2022), <https://www.amazon.science/latest-news/the-quest-to-deploy-autonomous-robots-within-amazon-fulfillment-centers>).

⁸⁵ See KAIF10007692 (*Inside the Amazon Warehouse Where Humans and Machines Become One*, <https://www.wired.com/story/amazon-warehouse-robots/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	instance, enjoy basking in the photons that pour through skylights. Above the robots' field, though, the skylights are covered, because the glare might throw off the machines' sensors. To navigate, they're using a camera on their bellies that reads QR codes on the ground. Even the air-conditioning units hanging from the roof are modified. On the For example, according to Amazon "to navigate a camera on the robot's undercarriage reads QR codes embedded in the floor."⁸⁶ On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation. This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.
[b] a distance measuring unit for measuring a distance to the location recognition tag;	The Accused Instrumentalities comprise a distance measuring unit. The distance measuring unit is configured to measure a distance to the location recognition tag. For example, Kiva can determine and adjust its location.⁸⁷

⁸⁶ See KAIFI0007817 (*Inside Amazon's Smart Warehouse* (Nov 29, 2020), <https://www.youtube.com/watch?v=IMPbKVb8y8s>).

⁸⁷ See KAIFI0004434 (*Squat and Smart* (July 2008), https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	Their innovation was to put bar-code stickers on the floor and equip the robots with cameras to read them. As the robots move, they read the encoded information to learn their coordinates in the warehouse. At the same time, the robots' control systems determine how far off their bodies are from the center of the stickers. If, for instance, a robot is a bit off to the right, the control system nudges it to the left. For example, Kiva's control system determine how far off their bodies are from the center of the stickers.⁸⁸

²³#/p/22).

⁸⁸ See KAIFI0004451 (Kiva Systems: *Three Engineers, Hundreds of Robots, One Warehouse*, <https://spectrum.ieee.org/three-engineers-hundreds-of-robots-one-warehouse>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	Their innovation was to put bar-code stickers on the floor and equip the robots with cameras to read them. As the robots move, they read the encoded information to learn their coordinates in the warehouse. At the same time, the robots' control systems determine how far off their bodies are from the center of the stickers. If, for instance, a robot is a bit off to the right, the control system nudges it to the left. For example, Proteus uses advanced perception and navigation technology⁸⁹ Proteus autonomously moves through our facilities using advanced safety, perception, and navigation technology developed by Amazon. The robot was built to be automatically directed to perform its work and move around employees—meaning it has no need to be confined to restricted areas. It can operate in a manner that augments simple, safe interaction between technology and people—opening up a broader range of possible uses to help our employees—such as the lifting and movement of GoCarts, the non-automated, wheeled transports used to move packages through our facilities. For example, Amazon's AMRs measure distance to Fiducial Plus tags.⁹⁰

⁸⁹ See KAIFI0001098 (10 years of Amazon robotics: how robots help sort packages, move product, and improve safety (Jun. 21, 2022), <https://www.aboutamazon.com/news/operations/10-years-of-amazon-robotics-how-robots-help-sort-packages-move-product-and-improve-safety>).

⁹⁰ See KAIFI0007815 (The Story Behind Precision Autonomy (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	 STORAGE CELL DETECTION Local perception target – Fiducial Plus • Observable characteristic length • Soft modification Mapping: image plane ↔ ground plane For example, according to Amazon:⁹¹ So now you can see on the right-hand side we have a nice one-to-one mapping from the camera plane down to the ground plane. We use the camera's intrinsics and extra index calibrated in order to get that transform. This means we can apply a plethora of computer vision techniques segmentation geometry detection to understand this fiducial plus's estimate on the ground plane world in the physical world and then we complete the storage mission. On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation. This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being

⁹¹ *Id.* at 7:02.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.
[c] an image analyzing unit for analyzing an image of the location recognition tag processed by the image photographing unit, and obtaining corresponding location information and direction information of the location recognition tag; and	The Accused Instrumentalities comprise an image analyzing unit. The image analyzing unit is configured to analyze an image of the location recognition tag processed by the image photographing unit. The image analyzing unit is configured to obtain corresponding location information and direction information of the location recognition tag. For example, Kiva comprises cameras that read two-dimensional bar-coded stickers laid out in a grid.⁹²

⁹² See KAIFI0004434 (*Squat and Smart* (July 2008), https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=23#/p/22).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	the system. The robots, he explains, navigate the warehouse by pointing cameras at the floor that read two-dimensional bar-coded stickers laid out by hand 1 meter from each other, in a grid. The robots relay the encoded information wirelessly to a computer cluster that functions both as a dispatcher and a traffic controller. It instructs, for instance, robot No. 1051 to bring rack No. 308 to worker No. 12—without colliding with robot No. 1433, which is crossing its path. For example, Kiva uses a distributed-control approach.⁹³

⁹³ See *id.*

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

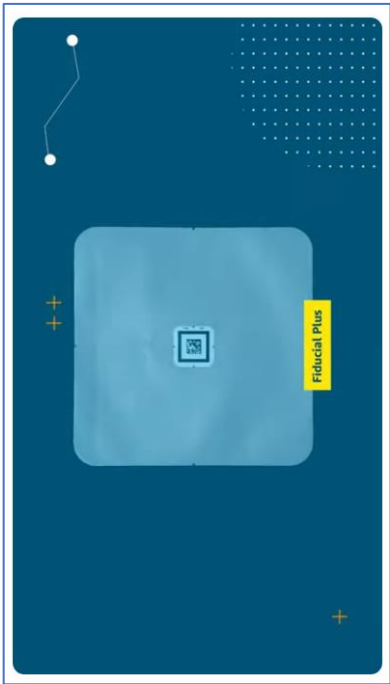
Claim 8	Accused Instrumentality(ies)
	The control system also reports its readings to the computer cluster to share that information with other robots. This distributed-control approach improves their navigation capabilities. Say a robot sees certain stickers off to the left. Instead of simply correcting its course by turning to the right, the robot first checks what other robots see—what the “wisdom of the crowd” is. If most of them see cen- tered stickers, the robot figures that the stickers are in the right place and that the shift in position is due to inherent imperfections with its own hardware—its camera may be off center or its wheels misaligned. The robot then adjusts its own control parameters to navigate more accurately. In fact, the machines drive so meticulously that their rubber wheels leave precisely aligned tracks on the warehouse floor.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	The greatest advantage of this approach is that the robots are mechanically simpler, and therefore cheaper. Rather than equipping the robots with expensive, high-precision parts to ensure they drive in straight lines, Kiva lets the control software take care of the variations and imperfections in the hardware components. “We don’t have to buy the best motors, the best gear boxes to make the robots reliable,” says Dennis Polic, one of the electrical engineers. “The control system takes care of that.” For example, Kiva comprises an image processing board.⁹⁴

⁹⁴ See KAIFI0006779 (Ben Einstein, *Meet the drone that already delivers your packages, Kiva robot teardown* (Feb. 1, 2016), <https://robohub.org/meet-the-drone-that-already-delivers-your-packages-kiva-robot-teardown/>).

Appendix E Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	Tucked inside the lifter mechanism is one of the key enablers of the Kiva system: a dual-camera imaging module. One camera looks down at the ground to recognize 2D barcodes on the warehouse floor. The other looks upwards at the bottom of every pod. Each has 6 on-board red LEDs for illumination and like the rest of the robot, everything is custom designed. Sandwiched between the two imagers is an image processing board sporting an ADI ADSP-BF548 Blackfin multimedia processor which is doing the Datamatrix detection and relaying results via high-speed serial. For example, Proteus comprises cameras that read bar-codes.⁹⁵ 

⁹⁵ See KAIF10007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	STORAGE CELL DETECTION Local perception target – Fiducial Plus • Observable characteristic length • Soft modification Mapping: image plane ↔ ground plane  PUTTING IT TOGETHER WITH PROTEUS  adjustments are performed with upward and downward-facing cameras

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	PUTTING IT TOGETHER WITH PROTEUS and downward-facing cameras that can see precision barcodes Global Slam 1000mm 100mm 10mm 1mm

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	The diagram illustrates a sensor's field of view. A central image shows a street scene with cars. To the left, a vertical scale bar is marked with '100' at the top and '1mm' at the bottom. To the right, a horizontal scale bar is marked with '10mm' at the top and '1mm' at the bottom. Two yellow boxes are present: one labeled 'Local Perception' pointing to the central image, and another labeled 'Precision Anchors' pointing to a small square icon in the bottom right corner. GOCART DETECTION • Local perception target – GoCart itself • Lidar clustering – known geometry The diagram shows a 3D point cloud of a street scene. A yellow rectangular box highlights a specific area within the point cloud, representing the 'Local perception target'. A small inset image in the bottom right corner shows a street scene with cars, similar to the one in the first diagram.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	For example, Proteus uses a distributed-control approach.⁹⁶ <i>Proteus autonomously moves through our facilities using advanced safety, perception, and navigation technology developed by Amazon. The robot was built to be automatically directed to perform its work and move around employees—meaning it has no need to be confined to restricted areas. It can operate in a manner that augments simple, safe interaction between technology and people—opening up a broader range of possible uses to help our employees—such as the lifting and movement of GoCarts, the nonautomated, wheeled transports used to move packages through our facilities.</i> For example, Proteus utilizes an on-board computer and control boards.⁹⁷

⁹⁶ See KAIFI0001260 (Evan Ackerman, *Amazon Shows Off Impressive New Warehouse Robots > It's a lot of progress over just one year* (Jun. 23, 2022), <https://spectrum.ieee.org/amazon-warehouse-robots>).

⁹⁷ See KAIFI0006967 (*Proteus*, <https://robotsguide.com/robots/proteus>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	SENSORS Vision system with cameras and high-precision lidar for perception and navigation, including maneuvering underneath carts and reading fiducials on the ground. Upward and downward-facing cameras to read barcodes. Other collision-avoidance sensors. ACTUATORS Motors to drive wheels and power lifting mechanism. COMPUTE On-board computer and control boards. Colored lights and LED "eyes" for human-robot interaction. SOFTWARE Custom robot control system. Integrated with fleet management software stack and Amazon's warehouse management systems. For example, Amazon's AMRs analyze Fiducial Plus tags to obtain location information and direction information corresponding to those tags.⁹⁸

⁹⁸ See KAIF10007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	STORAGE CELL DETECTION Local perception target – Fiducial Plus • Observable characteristic length • Soft modification Mapping: image plane ↔ ground plane  According to Amazon.⁹⁹ Transcript: next we'll talk about this new fiducial plus which is a custom-made ground target which allows us to detect storage cells and do precision alignment. So now you can see on the right-hand side we have a nice one-to-one mapping from the camera plane down to the ground plane. We use the camera's intrinsics and extra index calibrated in order to get that transform. This means we can apply a plethora of computer vision techniques segmentation geometry detection to understand this fiducial plus's estimate on the ground plane world in the physical world and then we complete the storage mission.

⁹⁹ *Id.* at 5:17, 7:02, 7:30.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	On the right hand side you'll see the vehicle detecting with its front camera the fiducial plus to perform an alignment. On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation. This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.
[d] a location recognizing unit for recognizing a user location by using distance information measured by the distance measuring unit, and the location information and the direction information obtained by the image analyzing unit.	The Accused Instrumentalities comprise a location recognizing unit. The location recognizing unit is configured to recognize a user location by using distance information measured by the distance measuring unit, and the location information and the direction information obtained by the image analyzing unit. For example, see evidence of Amazon's infringement in 8(a), 8(b) and 8(c) above. For example, Kiva uses a software system to tie distance information, location information and direction information together.¹⁰⁰

¹⁰⁰ See KAIFI0006779 (Ben Einstein, *Meet the drone that already delivers your packages, Kiva robot teardown* (Feb. 1, 2016), <https://robohub.org/meet-the-drone-that-already-delivers-your-packages-kiva-robot-teardown/>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	The system Kiva developed comprises on 5 key components: • Custom designed Kiva shelves ("pods") that are mobile and highly flexible • A grid of 2D QR codes implanted on the floor (known as "fiducials") • An intelligent pack station decked out with scales, lasers, and sensors • Herculean orange robots that swiftly lift and move the pods around the floor • And most important of all: a complex and robust software system tying everything together While all these components are amazing in their own right (and necessary for the system to function), this post focuses on the bright orange bots droning around the warehouse floor. For example, Proteus uses custom robot control system software.¹⁰¹

¹⁰¹ See KAIF10006967 (*Proteus*, <https://robotsguide.com/robots/proteus>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	SENSORS Vision system with cameras and high-precision lidar for perception and navigation, including maneuvering underneath carts and reading fiducials on the ground. Upward and downward-facing cameras to read barcodes. Other collision-avoidance sensors. ACTUATORS Motors to drive wheels and power lifting mechanism. COMPUTE On-board computer and control boards. Colored lights and LED "eyes" for human-robot interaction. SOFTWARE Custom robot control system. Integrated with fleet management software stack and Amazon's warehouse management systems. For example, Amazon's AMRs use Fiducial Plus tags.¹⁰²

¹⁰² See KAIF10007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	For example, according to Amazon:¹⁰³ So now you can see on the right-hand side we have a nice one-to-one mapping from the camera plane down to the ground plane. We use the camera's intrinsic and extra index calibrated in order to get that transform. This means we can apply a plethora of computer vision techniques segmentation geometry detection to understand this fiducial plus's estimate on the ground plane world in the physical world and then we complete the storage mission. On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation.

¹⁰³ *Id.* at 7:02.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 8	Accused Instrumentality(ies)
	This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.

Claim 10 of the '001 Patent

Claim 10	Accused Instrumentality(ies)
The location recognition device of claim 8, further comprising a tag location information storage unit for storing location coordinate information of a location of the location recognition tag, and logic location coordinate information corresponding to the location coordinate information.	The Accused Instrumentalities comprise a tag location information storage unit for storing location coordinate information of a location of the location recognition tag, and logic location coordinate information corresponding to the location coordinate information. For example, Kiwa comprises cameras that read two-dimensional bar-coded stickers laid out in a grid. ¹⁰⁴

¹⁰⁴ See KAIF10004434 (*Squat and Smart* (July 2008), https://www.nxtbook.com/nxtbooks/ieee/spectrum_na_0708/index.php?startid=23#/p/22).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 10	Accused Instrumentality(ies)
	the system. The robots, he explains, navigate the warehouse by pointing cameras at the floor that read two-dimensional bar-coded stickers laid out by hand 1 meter from each other, in a grid. The robots relay the encoded information wirelessly to a computer cluster that functions both as a dispatcher and a traffic controller. It instructs, for instance, robot No. 1051 to bring rack No. 308 to worker No. 12—without colliding with robot No. 1433, which is crossing its path. For example, Kiva uses a distributed-control approach.¹⁰⁵

¹⁰⁵ See *id.*

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

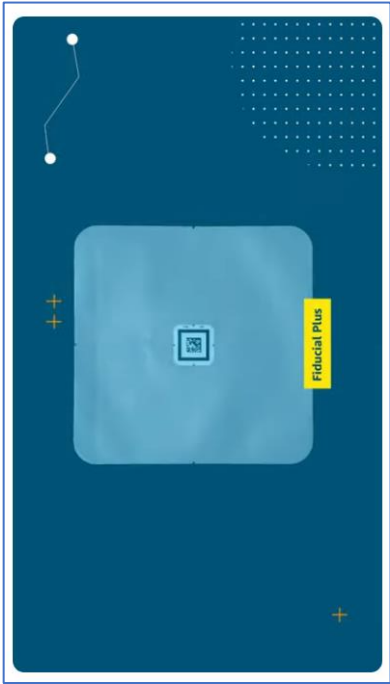
Claim 10	Accused Instrumentality(ies)
	The control system also reports its readings to the computer cluster to share that information with other robots. This distributed-control approach improves their navigation capabilities. Say a robot sees certain stickers off to the left. Instead of simply correcting its course by turning to the right, the robot first checks what other robots see—what the “wisdom of the crowd” is. If most of them see cen- tered stickers, the robot figures that the stickers are in the right place and that the shift in position is due to inherent imperfections with its own hardware—its camera may be off center or its wheels misaligned. The robot then adjusts its own control parameters to navigate more accurately. In fact, the machines drive so meticulously that their rubber wheels leave precisely aligned tracks on the warehouse floor.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 10	Accused Instrumentality(ies)
	The greatest advantage of this approach is that the robots are mechanically simpler, and therefore cheaper. Rather than equipping the robots with expensive, high-precision parts to ensure they drive in straight lines, Kiva lets the control software take care of the variations and imperfections in the hardware components. "We don't have to buy the best motors, the best gear boxes to make the robots reliable," says Dennis Polic, one of the electrical engineers. "The control system takes care of that." For example, Kiva comprises an image processing board.¹⁰⁶

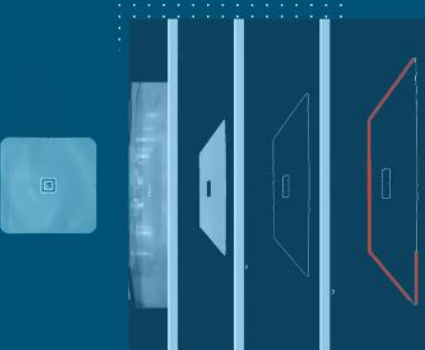
¹⁰⁶ See KAIFI0006779 (Ben Einstein, *Meet the drone that already delivers your packages, Kiva robot teardown* (Feb. 1, 2016), <https://robohub.org/meet-the-drone-that-already-delivers-your-packages-kiva-robot-teardown/>).

Appendix E Claim Chart for U.S. Patent No. 7,689,001

Claim 10	Accused Instrumentality(ies)
	Tucked inside the lifter mechanism is one of the key enablers of the Kiva system: a dual-camera imaging module. One camera looks down at the ground to recognize 2D barcodes on the warehouse floor. The other looks upwards at the bottom of every pod. Each has 6 on-board red LEDs for illumination and like the rest of the robot, everything is custom designed. Sandwiched between the two imagers is an image processing board sporting an ADI ADSP-BF548 Blackfin multimedia processor which is doing the Datamatrix detection and relaying results via high-speed serial. For example, Proteus comprises cameras that read bar-codes.¹⁰⁷ 

¹⁰⁷ See KAIF10007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

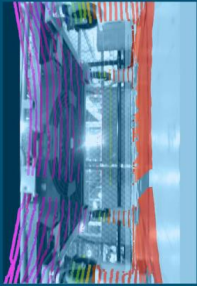
Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 10	Accused Instrumentality(ies)
	STORAGE CELL DETECTION Local perception target – Fiducial Plus • Observable characteristic length • Soft modification Mapping: image plane ↔ ground plane  PUTTING IT TOGETHER WITH PROTEUS  adjustments are performed with upward and downward-facing cameras

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 10	Accused Instrumentality(ies)
	The diagram shows a blue square with a white 'X' in the center. The 'X' is divided into four quadrants, each labeled with an accuracy level: 1000mm (top-left), 100mm (top-right), 10mm (bottom-left), and 1mm (bottom-right). A yellow box labeled 'Global Slam' is positioned in the center of the 'X'. The diagram shows a blue square with a white 'X' in the center. The 'X' is divided into four quadrants, each labeled with an accuracy level: 100mm (top-left), 10mm (top-right), 1mm (bottom-left), and 1mm (bottom-right). A yellow box labeled 'Local Perception' is positioned in the center of the 'X'. A yellow box labeled 'Precision Anchors' is positioned in the center of the 'X'.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 10	Accused Instrumentality(ies)
	GOCART DETECTION • Local perception target – GoCart itself • Lidar clustering – known geometry  For example, Proteus uses a distributed-control approach.¹⁰⁸ <i>Proteus autonomously moves through our facilities using advanced safety, perception, and navigation technology developed by Amazon. The robot was built to be automatically directed to perform its work and move around employees—meaning it has no need to be confined to restricted areas. It can operate in a manner that augments simple, safe interaction between technology and people—opening up a broader range of possible uses to help our employees—such as the lifting and movement of GoCarts, the nonautomated, wheeled transports used to move packages through our facilities.</i>

¹⁰⁸ See KAIFI0001260 (Evan Ackerman, *Amazon Shows Off Impressive New Warehouse Robots > It's a lot of progress over just one year* (Jun. 23, 2022), <https://spectrum.ieee.org/amazon-warehouse-robots>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 10	Accused Instrumentality(ies)
	For example, Proteus utilizes an on-board computer and control boards.¹⁰⁹ SENSORS Vision system with cameras and high-precision lidar for perception and navigation, including maneuvering underneath carts and reading fiducials on the ground. Upward and downward-facing cameras to read barcodes. Other collision-avoidance sensors. COMPUTE On-board computer and control boards. Colored lights and LED "eyes" for human-robot interaction. SOFTWARE Custom robot control system. Integrated with fleet management software stack and Amazon's warehouse management systems. ACTUATORS Motors to drive wheels and power lifting mechanism. For example, Amazon's AMRs analyze Fiducial Plus tags to obtain location information corresponding to those tags.¹¹⁰

¹⁰⁹ See KAIF10006967 (*Proteus*, <https://robotsguide.com/robots/proteus>).

¹¹⁰ See KAIF10007815 (*The Story Behind Precision Autonomy* (Aug. 23, 2022), <https://www.youtube.com/watch?v=0Hd9nZHolZQ>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 10	Accused Instrumentality(ies)
	 According to Amazon:¹¹¹ Transcript: next we'll talk about this new fiducial plus which is a custom-made ground target which allows us to detect storage cells and do precision alignment. So now you can see on the right-hand side we have a nice one-to-one mapping from the camera plane down to the ground plane. We use the camera's intrinsic and extra index calibrated in order to get that transformation. This means we can apply a plethora of computer vision techniques segmentation geometry detection to understand this fiducial plus's estimate on the ground plane world in the physical world and then we complete the storage mission. On the right hand side you'll see the vehicle detecting with its front camera the fiducial plus to perform an alignment.

¹¹¹ *Id.* at 5:17, 7:02, 7:30.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 10	Accused Instrumentality(ies)
	On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation. This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.

Claim 11 of the '001 Patent

Claim 11	Accused Instrumentality(ies)
The location recognition device of claim 8 or claim 10, wherein the location recognizing unit transmits the information obtained by the image analyzing unit to an external location managing server, receives location information calculated by the external location managing server, and recognizes a user location.	In the Accused Instrumentalities, the location recognizing unit transmits the information obtained by the image analyzing unit to an external location managing server, receives location information calculated by the external location managing server, and recognizes a user location. For example, Amazon's AMRs transmit information to and receive instructions from an external location managing server.

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 11	Accused Instrumentality(ies)
	Every day at Amazon fulfillment centers, more than half a million robots assist with stocking inventory, filling orders, and sorting packages for delivery. These robots follow directions provided by cloud-based algorithms and navigate along a grid of encoded markers. Virtual and physical barriers restrict their interactions with people, as well as where they can and cannot go. For example, according to Amazon, “cloud-based software operating what can fairly be described as an AI run air traffic control network.”¹¹² For example, Amazon has used Sequoia.¹¹³ 

¹¹² See KAIFI0007817 (*Inside Amazon's Smart Warehouse* (Nov 29, 2020), <https://www.youtube.com/watch?v=IMPBKVb8y8s>).

¹¹³ See KAIFI0001204 (Scott Dresser, *Amazon announces 2 new ways it's using robots to assist employees and deliver for customers* (Oct. 18, 2023), <https://www.aboutamazon.com/news/operations/amazon-introduces-new-robotics-solutions>).

Appendix E
Claim Chart for U.S. Patent No. 7,689,001

Claim 11	Accused Instrumentality(ies)
	With all of these efforts underway, it makes us particularly proud to share that we have just launched a new robotic system in time to help fulfill customer orders for holiday shopping this year. Sequoia is the name of this new technology, and it's now operating at one of our fulfillment centers in Houston, Texas. Building off a series of research and development efforts, Sequoia integrates multiple robot systems to containerize our inventory into totes, bringing together mobile robots, gantry systems, robotic arms, and a new ergonomic employee workstation. The system works by having mobile robots transport containerized inventory directly to a gantry, a tall frame with a platform supporting equipment that can either restock totes or send them to an employee to pick out inventory that customers have ordered. These totes come to employees at a newly-designed ergonomic workstation that allows them to do all their work in their power zone, between mid-thigh and mid-chest height. With this system, employees will no longer have to regularly reach above their heads or squat down to pick customer orders, supporting our efforts to reduce the risk of injuries. On information and belief, each of Amazon's AMRs rely on equivalent technologies in relation to this limitation. This claim element is literally present, as described herein, but is also satisfied under the doctrine of equivalents because the structure and functionality provided by Amazon is being used to satisfy this claim limitation and therefore there is no vitiation of this element, and the Accused Instrumentalities incorporate structure and functionality that is not substantially different from the requirements of this limitation because they achieve substantially or exactly the same function, in substantially or exactly the same way as set forth in the claim element (as described herein), and achieves substantially or exactly the same result.