How Locus Robotics Plans to Build a Successor to Amazon's Kiva Robots

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Posted 10 Aug 2016 | 17:01 GMT

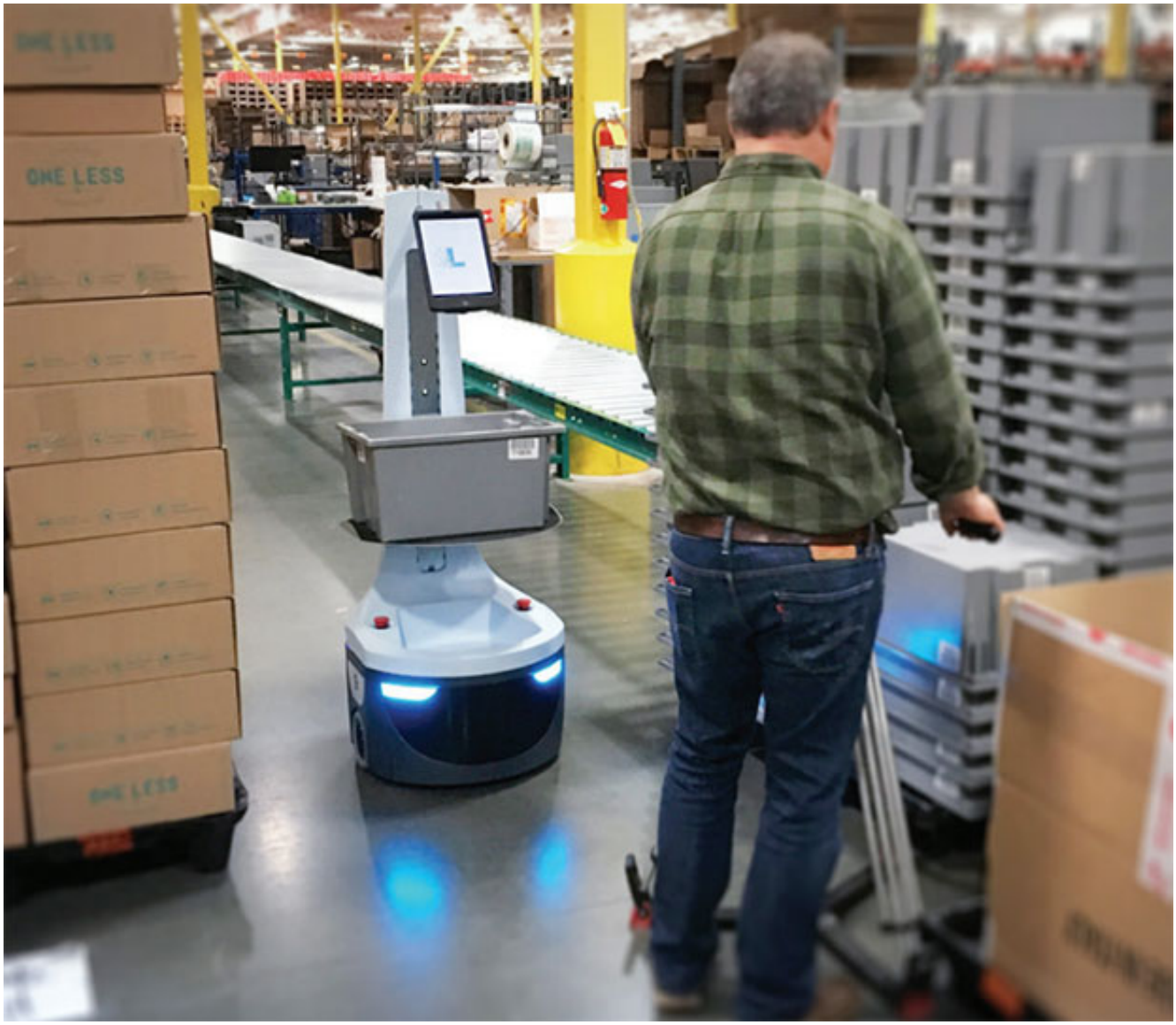

Photo: Locus Robotics

Locus' robots are designed to work collaboratively with human workers in a warehouse. When a worker sees a robot waiting near a shelf, the worker reads the item needed off a screen, picks the item, and places it on the robot. The robot then drives to the location of the next item. Locus says it's an efficient system because humans are doing what they're best at, which is identifying and picking objects off of shelves.

In 2012, Amazon bought Kiva Systems for just over three quarters of a billion dollars (http://spectrum.ieee.org/automaton/robotics/industrial-robots/amazon-acquires-kiva-systems-for-775-million), securing for itself virtually the entire large-scale robotic logistics market all at once. This was a particular problem for existing Kiva

customers, including Quiet Logistics (http://www.quietlogistics.com/), who used Kiva robots to support centralized warehouse operations (http://spectrum.ieee.org/robotics/robotics-software/three-engineers-hundreds-of-robots-one-warehouse) for a variety of clients. Once Quiet Logistics' contract with Kiva ran out, they'd need to find some new robots.

Recognizing the enormous value that Kiva robots provided (http://spectrum.ieee.org/automaton/robotics/industrial-robots/why-kiva-is-worth-775-million-to-amazon) and the potential of the void that suddenly existed, a bunch of companies began to target the robotic warehouse fulfillment space. There's Adept (http://spectrum.ieee.org/automaton/robotics/industrial-robots/adept-introduces-lynx-autonomous-mobile-platform), Fetch (http://spectrum.ieee.org/automaton/robotics/industrial-robots/fetch-robotics-introduces-fetch-and-freight-your-warehouse-is-now-automated), Clearpath (http://spectrum.ieee.org/automaton/robotics/industrial-robots/miniaturized-sibling-of-otto-material-handling-robot-joins-clearpath-fleet), IAM Robotics (http://spectrum.ieee.org/automaton/robotics/industrial-robots/iam-robotics-takes-on-automated-warehouse-picking), and Magazino (http://spectrum.ieee.org/automaton/robotics/industrial-robots/german-warehouse-robots-tackle-picking-tasks), to name just a few. Rather than rely on a new platform from someone else, Quiet Logistics decided to develop its own fulfillment robot. Quiet's internal robotics project was spun out into Locus Robotics in 2014, with $8 million in Series A funding announced this May. Bruce Welty (http://www.locusrobotics.com/about.php) is the chairman of Quiet Logistics, as well as the founder and chairman of Locus Robotics. We spoke to him about the problems he saw with Kiva's robots, how to develop a robot from scratch, and why warehouse robotics is predominantly a software problem.

Locus' robot is designed to work collaboratively with humans to fill orders in a warehouse. It's a mobile base that can navigate autonomously using lidar (http://spectrum.ieee.org/tag/lidar) to track its location in a pre-mapped area, with cameras and 2D barcodes for verification. Each robot knows the location of every item in the warehouse, and when an item needs to be picked for an order, the robot will navigate to that item and wait.

Humans workers are assigned to patrol warehouse zones, and when they see a robot waiting, the worker reads the item that it needs off the screen, picks it, and moves on. The robot then drives to the location of the next item that it needs, or heads for a shipping station. It's a very efficient system, since humans aren't carrying anything or having to roam all over a warehouse to fulfill one order: instead, they're doing what they're best at, which is identifying and picking objects off of shelves.

The following video is an excerpt from a talk by Mike Johnson, Locus Robotics's president, that shows the system in action:

Here's our interview with Locus Robotics' chairman Bruce Welty.

***IEEE Spectrum*: Can you give us a brief history of Locus?**

Bruce Welty: Locus was incubated inside of Quiet Logistics: originally they were the same company. The reason that we started the company was that Quiet was a user of Kiva's robots, and when Amazon acquired Kiva, we decided we needed our own technology. We actually started thinking about the design of this particular robot starting in about 2010, when we became familiar with Kiva. We liked a lot of things about Kiva, but there were also a lot of things about Kiva that we didn't like. So, we were always thinking about the next generation of robots.

What didn't you like about Kiva's robots, and how did that inform your thinking about what you wanted to create with Locus?

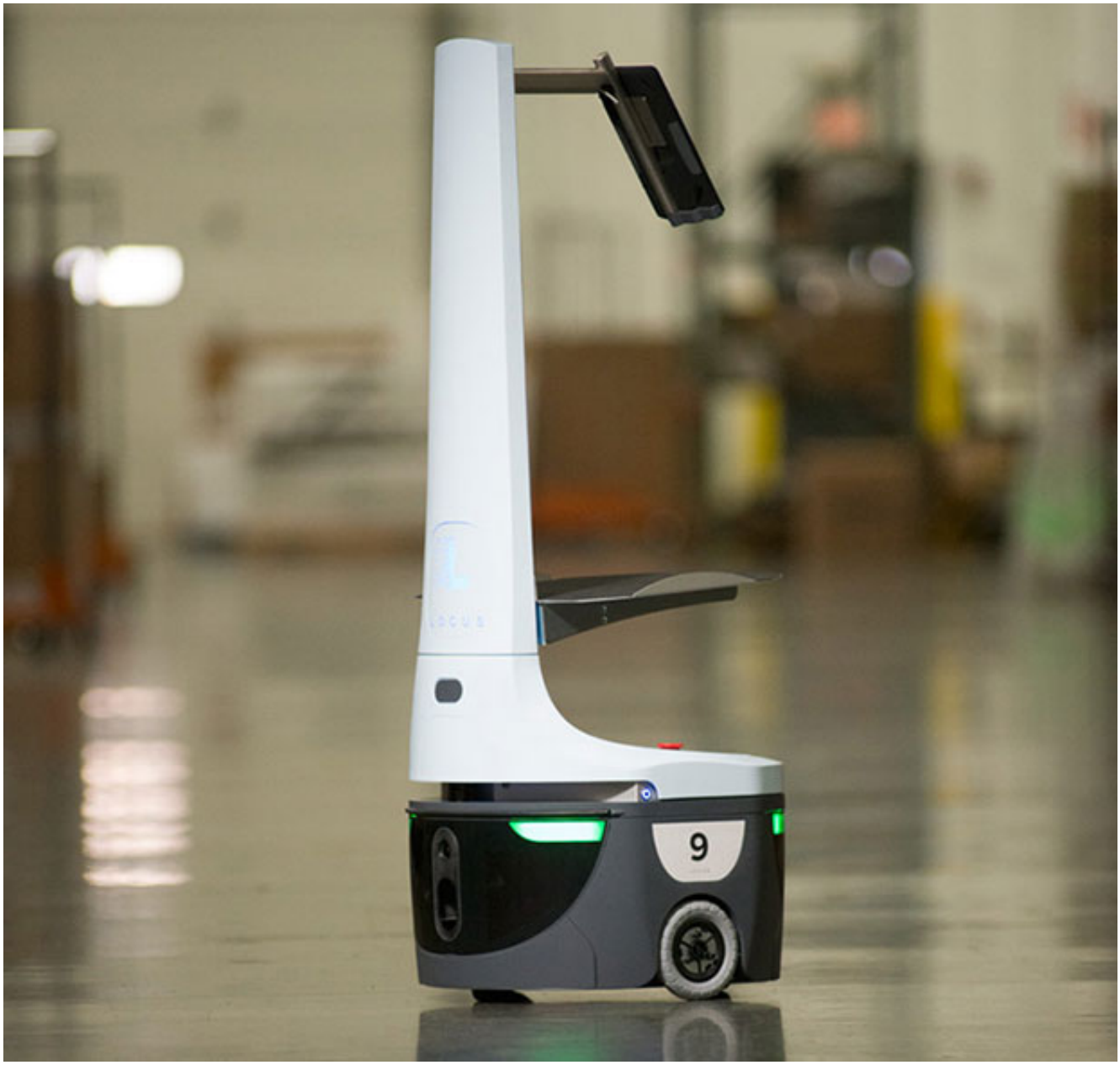

Photo: Locus Robotics

The main things that we didn’t like about Kiva really came down to ease of use, expense, and safety. As you might imagine, the very first iteration of something is about making it work. So, Kiva wasn’t really that concerned about cost, or how much work it was to implement. They didn’t think about the implications of how much it weighed, or whether or not it was safe around people, since the robot space excluded people.

Things started to drive us crazy: the pods [shelf units] were very expensive. The robots were open to the air, and so dust would get inside them, which caused 90 percent of our maintenance issues. We also didn’t like that Kiva kept the inventory sequestered off

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somewhere in the building. Our view was, we needed to have something where we would control the inventory. We had to come up with a robot that didn't need to have those pods.

We also needed something that could operate in existing infrastructure. Kiva's technology was built in 2002 and 2003, and the state of the art back then was such that the lidar and the cameras that we use right now just weren't affordable. We have a much more sophisticated navigation system that allows us to handle multi-robot navigation. Kiva really didn't do that. [Kiva robots] have their own path, and nobody can cross that path while they own it. In our case, our robots are able to avoid each other and cross each other's paths, seeing each other and reacting in realtime to changes in the environment.

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—Bruce Welty, Locus Robotics

How did you get started designing a new robot?

To build the robot, we started with a kit right out of a hobbyist catalog, and we literally built an Arduino (https://spectrum.ieee.org/tag/arduino)-based robot. We realized quickly that the problem was not a hardware problem but a software problem, which made us happy because we're software people. That comes down to another big innovation that occurred, which was when Willow Garage made all of their software open source, when they published that out into ROS (http://spectrum.ieee.org/tag/ros). We didn't have to invent everything from scratch, we could start with basic functionality and just enhance it to do what we wanted it to do.

After we got the robot able to navigate, which probably took us about six versions of robot from kits, ultimately we built our own robot from the ground up. The first seven robots were just the base, with the ability to navigate. The eighth, ninth, and tenth robots that we built, we put an armature on top, that handles ergonomics, load management, and interaction with the human.

As you went from your first prototype to your final design, what lessons did you learn?

First of all, we learned that it's a software problem. At the end of the day, the robot is a very small piece of it. Secondly, we realized that over time, the robots were going to get smarter, in the sense that Moore's Law would apply, and the robot's capabilities would increase exponentially. So we quickly became very bold about how we put a lot of intelligence on our robot. The other thing that we learned is that robots create enormous amounts of data, so we had to get really clever about what data we did and didn't keep, and where we stored it, and how we pass data around to minimize network traffic. There's also the fact that sensors are getting so cheap now that we're starting to add a lot more sensing capabilities to the robots because it's getting less and less expensive, and we're expecting that trend to continue.

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What differentiates you from other companies working on warehouse fulfillment robots?

My impression of everyone else who has entered this space is that they're brilliant roboticists who have come into a market that they know nothing about. They don't really, truly understand the business problem, and they're going to rely on other people to help them figure that out. We're way down that path: because we know how warehouses work, and we already anticipate what kinds of questions are going to be asked.

Our robots are very specifically designed and built to solve a very specific problem. And that's a big differentiator, because we're going to be delivering a complete system, not just a robot. I think that the robot is 20 percent of the problem; I think our competitors are solving 20 percent of the problem by developing the robot, and they're more or less going after all of these opportunities with just a piece of hardware. Sort of like, if someone wants to buy a desk, and you sell them a hammer.

If the robot is 20 percent of the problem and Locus is an expert in this space, why build your own robot from scratch as opposed to working with a robotics company on the hardware?

Two reasons: we see that the two components are very tightly coupled; we didn't want a robot that did anything more than we need, or less than we need. Everyone we looked at had a robot that did either more or less. The second reason is that we were [previously] in a position where we had a vendor [Kiva] that was acquired by a competitor [Amazon], and we felt that we couldn't take the risk.

It's also the case that if you think that 80 percent of the solution is the knowledge and the software that goes on top of the robot, then in our view, the robot's worthless without that 80 percent. So our view is that if we worked really really hard with [a robotics company], we'd be creating a very valuable business for them, and the market is enormous. We see this as being a multi-billion dollar opportunity, maybe tens of billions of dollars. Why would we want to give anybody else all of this knowledge, when we could do it ourselves, and all we really have to add is that 20 percent?

What you think about the future of robotic warehouse fulfillment? Do you see robots evolving to the point where they will actually be able to take over the actual picking task or do you think humans will be more efficient or cost-effective for that in the medium term?

I think it's going to be a very gradual process. It'll take a long time before humans are out of the picture completely. There are companies that have already implemented technologies that can pick things like boxes and bottles using suction cups and grippers and things like that, but then there's this continuum of products, shapes and sizes and weights, and densities, and so on, that are very challenging for computers to pick.

[For a robot that can pick], we need four things to be right: we need it to be robust, we need it to be reliable, we need it to be fast, and we need it to be cheap. Right now, it’s none of those things. Even if it did work beautifully and everything was great and it was fast, humans are still cheaper. Some people think it’s a one- to two-year problem. I’m not in that camp. Some people think it’s a three- to five-year problem, some people that are in that camp could be right. Personally, I think it’s a five- to seven-year problem. It might be more than that, even. I’ve been in warehouses my whole career, and they’re very, very difficult places to work. And I think robots are just not good at dealing with things that are not in a predictable state.

[Locus Robotics (http://www.locusrobotics.com/)]