Knightscope's autonomous security robots patrol with superhuman acuity and detection prowess

A fusion of innovative robotics, self-driving technology, vehicle electrification and artificial intelligence

`The concept of automated policing began as a science-fiction concept years ago, but today it is real and impactful. The sophistication of robot-powered security is actually even more interesting if you spend a few minutes talking to Stacy Stephens, the co-founder and chief client officer of Knightscope, Inc.

Launched in 2013, the Mountain View, CA, public safety technology services company was the first in the world to deploy mobile, fully autonomous security robots (ASRs) in public spaces such as malls, parking lots and neighborhood parks. The Knightscope vision was to find a more effective means of deterring crime while minimizing risk to law enforcement officers.

Describing Knightscope as a leading public safety tech company, rather than a robotics organization, Stephens said their expertise includes a fusion of robotics, self-driving technology, vehicle electrification and artificial intelligence. Combined, they yield an agile platform upon which numerous types of sensing capabilities and other technologies can be integrated to provide actionable intelligence.

Next-generation of ASR surveillance capability

Knightscope ASRs have a wide array of features and capabilities. These include a 360-degree 4K video system, two-way audio, license plate recognition, thermal imaging, people detection, facial recognition and signal detection for mobile devices.

ASRs are equipped to scan for known threats, allowing companies to reduce workplace violence by providing facial recognition capabilities and parking lot security by using exception monitoring to ID the license plates of cars that don't belong on site.

With their audio feature, ASRs provide two-way communication, giving the robots broadcast capability that allows them to engage with the surrounding environment. This permits first responders to de-escalate hostile situations by putting a robot in place of a person.

"The ASR's 'talk-down' feature takes the danger off the human and puts it on the robot," Stephens said. "Robots are a nondescript object that allow a conversation to take place without having a person in front of a hostile suspect that could unintentionally escalate the situation."

ASRs also can be used as a public address system in the event a building must be quickly evacuated. In addition to spotting bad actors, the ASR's facial recognition feature is used by one casino to identify VIPs, who are now greeted before they even enter the building.

As Stephens points out, ASRs take on boring, routine and monotonous activities that free up security personnel for more hands-on, strategic or customer service-related activities. And they reduce the likelihood of injury and death for both public safety professionals and perpetrators.

"They also lower operating overhead," Stephens said. "ASRs never get sick, and they don't take vacations."

Infusing technology to drive ASR autonomy

All of Knightscope's mobile robots are completely autonomous, using a system of LIDAR, GPS, sonar, IMUs, 4K cameras and high-fidelity audio. Just as people have five senses, the robot has five sensor types to manage its surroundings. And in nearly every instance, the robot's senses are more acute than a public safety officers.

The first of these, situated on top of the robot, is the LIDAR. This includes a series of lasers with another set positioned at eye-level, along the robot's waistline, on

Knightscope's mobile robots are completely autonomous, using a system of LIDAR, GPS, sonar, IMUs, 4K cameras and high-fidelity audio. The robot has five sensor types–similar to humans but with far greater acuity.

Knightscope ASR can patrol indoors and out with incredible dexterity because of the many highly-refined sensors. Together, the five sensor modalities paint an incredibly accurate picture of the robot's geofenced environment and allow the ASR to successfully navigate complex environments while avoiding people, animals and objects.

the backside and two more along the skirt. In all, 21 lasers map the surrounding area every 25 milliseconds. That data is used to create a 3D map of the area around the robot out to a 100-meter radius, which enables the ASR to "see" its environment.

Secondly, sonar sensors are located around the robot to provide proximity sensing that allows the robot to tell when something is physically close. This allows the ASR to take evasive action or communicate with an approaching person. GPS is included as a tertiary input for internal navigation and helps track the machine in the event that someone were to attempt to move or steal the robot.

Odometry sensors calculate wheel rotation to indicate if the robot is moving or tracking left or right. And finally, an inertial measurement unit, or IMU, provides six-degrees-of-freedom spatial awareness to determine if the robot is upright or tilted, which could signal it has become stuck or immobilized.

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AI and edge computing process data at lightning speeds

The ASR architecture is built so that the data is constantly streamed and recorded. That creates about 90 terabytes of data per robot per year, which no human could process. Data is stored for up to 30 days, which is the typical security industry standard for data retention.

Data is stored both on the robot and in the cloud, depending on the situation. The difference between the two sets of data is associated with the threat level. If a threat is detected, the data is simultaneously sent to the cloud and triggers an alert. If the robot is just recording video as it patrols the park, then immediate access to the cloud is not necessary and the data is stored on a local hard drive.

Artificial intelligence is used on the navigation stack and to analyze different parts of the video stream. For example, AI is used for people detection and to enable facial recognition systems to determine the similarity ratio of a detected face versus one in the user-generated database. That could be used, for example, to look for a lost child at a park or festival grounds. AI is also used for license plate recognition, especially because the 50 U.S. states have so many different kinds of plates, personalized and otherwise.

Power efficiency is paramount to ASRs

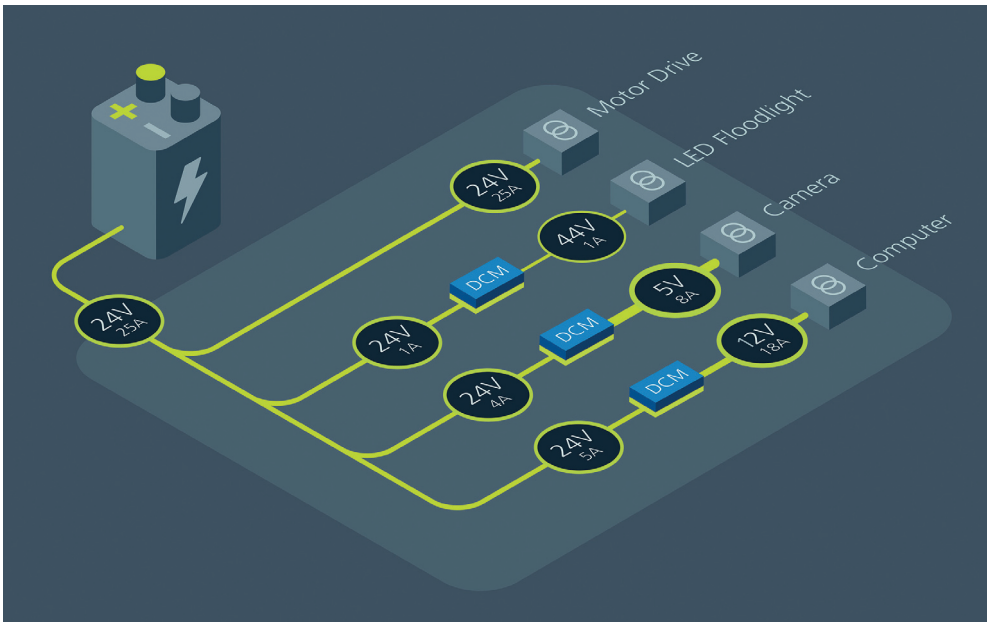
The intense level of computing, communications, and sensing places a tremendous burden on the ASRs' power delivery networks (PDN). The PDN must be compact and have high efficiency. Because the ASRs have no airflow or venting, Knightscope went hunting for a pure conduction-cooled solution that could use the aluminum skin as a heat sink. The company adopted a Vicor DC-DC converter module (DCM3623) because its unique ChiP™ (Converter housed in Package) design was thermally adept and very small. The high DCM™ power density also helped with routing the wiring and cable assembly and increased battery efficiency, performance and runtime.

As Stephens explained, "Unlike an electric car, the goal is not to maximize range. It's more about maximizing robot run-time and minimizing the charge time, because it operates 24/7/365."

On the electrical side, the robot required isolation from all of the different power rails. Because there are so many sensors with different EMI signatures, the Vicor DCM helped minimize EMI and noise interference.

Knightscope has a long roadmap of features and capabilities that can be added to the robots. In this case, Vicor DCMs provide a scalable platform and uniform height that obviates the need to change the heat sinking or mechanical components.

"The more we're able to reduce the burden on the battery, the longer run-time we will get," Stephens said. "So, power's always, always going to be a



A typical mobile robotics application powers a variety loads ranging from computers to motor drive and cameras. Similarly, Knightscope powers LIDAR, GPS, sonar, IMUs, 4K cameras and high-fidelity audio and uses Vicor high-density power modules to power these loads. Knightscope sought power that was compact and highly efficient because the ASRs have no airflow or venting. They needed a pure conduction-cooled solution that could use the aluminum skin as a heat sink.

consideration. And, ultimately, all of this will help us achieve our vision for the company, which is that when an architect sits down to plan a commercial development or a mixed-use space, we're part of the security check list along with things like smoke detectors and fire suppression systems."

Knightscope's robots can be seen protecting office parks, corporate campuses, airports, schools and casinos, having a real impact in the world of security and surveillance and causing organizations to rethink how they will protect their property and people. This technology-infused robot, packed with sensors and detection systems, is more effective than humans because of its acute capabilities. Its unwavering attention to detail, rapid recognition, recall and ever-vigilant commitment to duty is an unmatched approach to safety and security. It appears there is a new sheriff in town, and the name is Knightscope.

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