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Global Outlook for Mobile Security Robots

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HOW UGVs AND ROBOTIC SYSTEMS ARE USED IN SECURITY APPLICATIONS

Unmanned ground vehicles and robotics are growing in the physical security market, providing support for guards and other security officials.
By Howard Carder

Military and law-enforcement authorities have been using unmanned ground vehicles, or UGVs, for more than 50 years, performing tasks where it was physically impractical or dangerous to have a human on board. Early remote-controlled UGVs performed tasks such as bomb detection and suppression. They also provided remote situational awareness.

Today, UGVs and other autonomous, unmanned robotics systems are moving from military to private industry applications, especially within the physical security sector, to assist guards and perform tedious or hazardous tasks.

UGVs and robotic security systems are more capable and autonomous, thanks to advances in computer processing power, wireless networks, and smart sensors for the Internet of Things (IoT).

Coupled with sharply decreasing costs for system components such as specialized cameras, navigation systems, and battery technologies, mobile robots can now perform more tasks reliably at a more affordable cost than before.

RESPONDING TO CRIME

Although property crimes have declined in the U.S., the need for affordable tools to monitor homes, sensitive utility and government sites, and corporate and university campuses remains urgent.

According to the 2016 edition of the FBI's annual *Crime in the United States* report, there were an estimated 7.9 million property crimes in the U.S. in 2016. Preliminary data from the first half of 2017 shows a 2.9% decrease in property crime, compared with the same time period in 2016. Since 2013, property crimes have decreased every year, the FBI says.

In 2016, burglaries dropped 4.6%, and larceny-thefts declined 1.5%, but motor vehicle thefts rose 7.4%. Collectively, property crime victims (excluding arson) suffered losses estimated at $15.6 billion in 2016.

Many public and private entities are looking for cost-effective ways to deter crime and protect people and property. UGVs and robots offer a blended approach to security, combining the attributes of a mobile security guard with the benefits of access control and video surveillance technologies.

From neutralizing threats in real time to capturing data for forensic investigation, autonomous systems can be effective in detecting and discouraging trespassers, vandals, theft, and break-ins.

TASKS AND SKILLS FOR UGVs

Today's autonomous systems can be equipped to perform several security-related tasks, including:

- Identifying and detecting objects of interest, such as people and vehicles
- Using sensors to detect environmental issues, such as gas leaks
- Collecting video data and providing a complete audit trail for review
- Acting as a visual deterrent to trespassers
- Sounding an audible siren or visible alarm (such as flashing a strobe)
- Making continuous and extended facility rounds, traveling between waypoints
- Acting as a gatekeeper at checkpoints
- Relaying real-time information to a remote operator for decisions and actions

ENABLING TECHNOLOGIES

UGVs typically fall into two categories: remote-operated and autonomous. In counterterrorism or hostage situations, UGVs and other security robots are often controlled by human operators. They gather visual and other data, but the human controllers determine navigational direction and any manipulation of objects.

Operators can control such robots over a facility's Wi-Fi network, with data relayed back to the operator or command center. Security robots can connect to existing security systems to capture video surveillance and sensor data.

An autonomous UGV operates without the need for a human controller. The vehicle uses onboard sensors to navigate an environment and relies on control algorithms to react to specific mission parameters. Autonomy eliminates the need for a human to watch over the often-tedious duties of the UGV.

Security robots also often feature a robust set of control systems, communication links, and systems-integration technologies. Depending on the tasks required, they can be equipped with a wide range of hardware devices and software applications, including:

- An array of fixed, variable (pan, tilt, zoom), and 360-degree panoramic video surveillance cameras that can capture video data for surveillance, detection, forensic investigation, and real-time situational awareness.
- High-resolution digital cameras, along with video analytics, for motion detection, facial recognition, and license-plate recognition.
- Onboard infrared technology to allow for low- or no-light camera viewing. Thermal imaging can also detect the heat signatures of people, animals, or vehicles, as well as gas leaks, through smoke, fog, or other obstacles.
- Integrated two-way audio communication lets operators talk with subjects remotely. The robot or UGV can also play public-address announcements or sound audible warnings. Telepresence functions can provide face-to-face communication with subjects and security personnel. Integration with a facility's access-control system can provide credential confirmation and employee, visitor, or intruder visual verification.
- Integration with fire and protection systems lets UGVs verify emergency situations and sound alarms. Long-distance laser and radar scanners can provide and extend range for perimeter security, even providing above-ground detection of drones and other threats.
- Global positioning systems (GPS) let the robots perform patrols of premises independently.

Photo Credit: Knightscope

HOW UGVs CAN ENHANCE SECURITY

The use of self-guided robots represents a new opportunity for the security industry.

Autonomous robots and UGVs can help facility managers and security teams increase the efficiency of patrols, enhancing organizational safety while realizing long-term cost reductions. By integrating robotic systems with other business systems, they can enable streamlined communications, deploy solutions at lower risk, and help boost sentry productivity.

Mobile robots can supplement the resources of an existing security staff, relieving guards of tedious, all-night rounds. They could even eliminate the need for some positions within larger departments.

For a smaller facility, a patrolling robot can serve as the primary "feet on the ground" for near-continuous patrolling of a facility's premises, allowing existing security staffers to make decisions in a safer location.

SECURITY ROBOTS AND ROI

For organizations concerned about the returns on their security investments, as component prices fall, a robot can be less expensive than a capital investment or purchase when offered through a robotics as a service (RaaS) model.

Mobile robots can save companies money by enabling them to more efficiently allocate human guards and centralize management. Automated routine patrols can be especially effective at larger facilities, where a large number of human guards are traditionally required to be on duty.

Photo Credit: Knightscope

Especially with large facilities and outdoor spaces such as parking lots, corporate campuses, and multi-building hospital facilities, UGVs can serve as a mobile, ground-level set of eyes and ears to help officers make smarter, safer, and faster decisions. Working with security professionals, organizations can be better equipped to cover all potential gaps in surveillance and communications.

In addition to serving as a visual deterrent to criminals, robots can even function as a public-facing ambassador and positive point of interest for visitors and the public. Still considered a novelty, a robot can make its presence known by greeting visitors by day, then perform its surveillance duties after hours.

WIDE APPLICATIONS

There are many examples of UGVs in use today within a variety of sites. Civilian UGV applications are being implemented to bring automatic processes to manufacturing and production environments.

As a way to deter the theft of copper and equipment, UGVs can be deployed in construction sites that are changing or where cameras or other infrastructure can't be placed.

Security UGVs can also work with warehouse management systems, autonomous forklifts, and conveyors to organize and transport inventory.

In addition, UGVs can be used in emergency situations including search and rescue and firefighting. After the 2011 Fukushima Daiichi nuclear power plant accident, mobile robots were used in Japan for mapping and structural assessment in areas that had too high levels of radiation to for humans to enter.

The DARPA Robotics Challenges were partly an effort to develop the technology for such hazardous situations, and research and testing are ongoing around a number of designs. In combination with aerial drones, UGVs can help secure large areas and locate people in difficult terrain.

Mobile patrolling is being increasingly seen at:
- Electrical power utilities and solar farms
- Oil and gas facilities, refineries, and chemical plants
- Airports and other large transportation hubs
- Prisons and law-enforcement facilities
- Mining and drilling sites
- Construction and building sites
- Warehouses and parking lots

AVAILABLE UGVs AND SUPPLIERS

Knightscope

Founded in 2013, Knightscope develops autonomous physical security solutions. The company provides a range of Autonomous Data Machines (ADMs) that can navigate through busy environments with moving objects.

Knightscope's long-term vision is to help predict and prevent crime utilizing autonomous robots, analytics and engagement. Its "Hardware + Software + Humans" approach provides advanced anomaly-detection capabilities.

In addition, Knightscope's mobile robots provide an autonomous physical presence, gathering data from the environment in real-time. They push anomalies to the Knightscope Security Operations Center (KSOC) user interface.

Cobalt Robotics

Cobalt Robotics says its robots combine the sensing, computation, reliability, unwavering attention, and perfect recall of a machine with the flexibility, cognition, and face-to-face interaction of a remote human pilot.

Its robots patrol autonomously, using cutting-edge machine learning to build models of "normal" environments. They can flag anomalies such as people, open doors, suspicious items, leaks, and unusual sounds.

Cobalt robots can either respond autonomously or allow remote pilots to have two-way audio/video chats for real-time responses. Industrial designer Yves Behar built Cobalt's intelligent indoor robot from the ground up to fit into indoor spaces and operate around people.

Robotic Assistance Devices

Robotic Assistance Devices (RAD) creates artificial intelligence and robotic solutions for operational, security, and monitoring needs. Founded in 2016, RAD is an exclusive technology partner of SMP Robotics (see below) for the development and production of autonomous UGVs.

Robotic Assistance Devices was formed by security and robotics technology leaders with a total of more than 100 years of industry management experience. It claims that its autonomous robotic solution can help organizations streamline operations, increase ROI, and strengthen safety.

SMP Robotics

SMP Robotics manufactures autonomous mobile robots. SMP Robotics' multinational offices allow for real-world pilot testing of how their robots operate in various climatic conditions.

The company began designing robots in 2009 in response to growing demand from the security services sector for mobile video surveillance at large facilities.

The main goal of SMP Robotics is to create and expand this new market segment for small, autonomous, commercial robots. To accomplish this, the company is building relationships with partners around the world.

OTSAW Digital

OTSAW Digital was founded in 2015 as a subsidiary and the digital arm of ActiV Technology, with the goal of helping improve business processes, environments, and everyday lives. With a global team of digital architects, OTSAW strives to bring innovation to robotics, mobile applications and IoT.

OTSAW offers a combination of a four-wheeled, self-driving vehicle and an unmanned aerial vehicle or drone, or UGV + UAV. Together with a formidable physical presence on site, OTSAW's outdoor security robot helps keep areas and facilities safe and secure.

KNIGHTSCOPE ADDS MOBILE, STATIONARY SENTRY ROBOTS TO RAAS LINE
By Mike Oitzman

Knightscope Inc. recently unveiled two new members of its family of security robots — the stationary K1 and the mobile K7. With a streamlined design and four large wheels, the K7 appears to be ready for the robot races. Criminals will think twice before attempting to outrun this robot, even if its initial speed is limited to 3 kph (1.8 mph).

The K1 security robot is unique in that it's a stationary platform, designed to be deployed at points of ingress and egress where it can record and watch people as they enter and leave a facility. The K1 will include the capability to detect concealed weapons, and it will be deployed in hospitals, airports, and other sensitive, public facilities. It will also have an optional radiation-detection capability.

Another key feature that Mountain View, Calif.-based Knightscope is working on is audio event detection in the indoor K3 robot. The K3 will be able to discriminate a sound by type, such as footsteps, glass breaking, or gunshots. The robot will also be able to determine sound origin relative to its positions. The K3 robot includes 16 microphones to help it triangulate the location of a sound. This feature will be available later this year.

More specifications and a discussion of the robotics as a service (RaaS) business model are below.

KNIGHTSCOPE GOES OFF-ROAD WITH THE K7

The K7 is designed to operate outdoors, off payment, in long-distance patrol applications.

This security robot could be especially useful for perimeter patrol duties in large facilities with a variety of terrain that are out of reach for its smaller siblings, the K3 and K5. This includes critical infrastructure such as:

- Airports
- Solar and wind farms
- Public infrastructure such as: water, power, and gas facilities
- Refineries
- Logistics facilities, seaports, and harbors

The Knightscope K7 provides the capability for offroad patrol duties.

Knightscope's sentry robots open a whole new segment of the market. According to the company, it is able to operate in almost any weather, and to actively patrol an area out of the line of site of a main facility. The K7 will be able to communicate with the main facility either via cellular or radio.

Here are a few of the K7's specs:

- Four-wheel drive with Holonomic steering
- Four 3D Velodyne VLP-16 LIDAR sensors
- Full 360-degree video camera coverage
- Weight: 700 lb.

K1 SENTRY ROBOTS STANDS GUARD

In a break from its mobile robot roots, Knightscope developed the stationary K1 to meet the need to pay special attention to people entering and exiting buildings. With a unique array of sensors, the sentry robots are intended to provide more capability than a simple security camera.

The K1 will have significant new features: an algorithm and sensor array that will enable it to recognize when a concealed weapon is being carried by someone entering a facility. The sentry robot could immediately alert its human counterparts, who would be better informed and more quickly able to contain and control the situation. This should lead to a better outcome for all involved. Over time, Knightscope may offer this capability its mobile robots.

EXISTING ROBOTS AS A SERVICE

Knightscope has already proven its mobile robot designs, including the Knightscope K3 for indoor facilities and the Knightscope K5 for outdoor, on-pavement facilities. The company currently has more than 36 customers across 22 cities in eight U.S. states. Knightscope has now logged over 100,000 miles and 180,000 hours of operation.

Notably, Knightscope is one of the first mobile robot manufacturers to offer its products in a RaaS business model. Many of its initial customers have re-upped their service contracts, proving that they value the sentry robot operations and that Knightscope is taking care of their needs.

In a RaaS contact, the customer doesn't own the robot, but rather obtains services in a subscription model. Knightscope offers its current line of robots for a service fee of $7 per hour. Knightscope owns its entire fleet of sentry robots in the field.

As a result, the company has an incentive to continue to innovate and improve its technology over time. There are no large, upfront costs to get started with a RaaS solution, making it attractive for industries that depend more on operational budgeting than capital budgeting.

Photo Credit: Knightscope

The K1 (left) expands the Knightscope product family.

SERVICE IS KING

Last year, Knightscope signed a strategic relationship with Konica Minolta Inc. in which Konica Minolta's field-service technicians — already skilled in servicing high-tech printing equipment — will exclusively service Knightscope sentry robots for its customers.

This is a critical part of the RaaS equation for Knightscope, because it can continue to invest in growing the company and developing its products while the service is outsourced to Konica Minolta.

In addition to being a strategic partner, Tokyo-based Konica Minolta has also invested $3 million into Knightscope in its latest investment round.

SECURITY IS A BIG MARKET

Worldwide, the security market is worth $500 billion. Knightscope isn't the only

player on this market, but it was one of the first to market with functional sentry robots, so it has a considerable lead over its competitors. Two other significant players in this market include Sharp Intellos and SMP Robotics.

Knightscope is also a past participant in the annual Pitchfire startup competition at the RoboBusiness conference.

Both the K1 and the K7 will go into production in mid-2018.