POLICY ESSAY

CCTV SURVEILLANCE FOR CRIME PREVENTION

The future of CCTV

Wesley G. Skogan

Northwestern University

Correspondence
Wesley G. Skogan, Institute for Policy Research, Northwestern University, 2040 Sheridan Road, Evanston, IL 60208.
Email: skogan@northwestern.edu

Erica Piza, Brandon Welsh, David Farrington, and Amanda Thomas (2019, this issue) present an updated systematic review of the effects of surveillance cameras on crime. The authors document the growth of closed-circuit television (CCTV) surveillance and note that the presence of cameras has become part of everyday life. Observing that the effectiveness of these systems as crime prevention tools was initially accepted without much real analysis, Piza et al. describe the increasing number and somewhat greater sophistication of evaluations that have since been conducted to document their capabilities. They conclude with a careful summary of the circumstances under which the adoption of CCTV seems to yield crime-prevention benefits.

Only a small section of the Piza et al. (2019) article is focused on the *future* of CCTV for that lies beyond its purpose. CCTV's close association with other digital technologies, the explosion in Internet-connected devices with complementary roles to play in crime prevention, and the rapidly changing tech world, however, indicates the future of CCTV may be about now, arriving just on the heels of the report by Piza et al. In this policy essay, I explore the immediate future and discuss an expansion in the scope of what CCTV looks like, focusing on a shift toward "proactivity" on the part of increasingly autonomous cameras; the growing number of license plate readers and linked traffic cameras; and emerging roles for drone cameras. Further into the future lies the most transformative CCTV technology of them all, facial recognition. What is stressed throughout is the importance of the increasingly integrated sensing and information processing network into which they feed, known more generically as "the Internet of Things."

1 │ CCTV GOES PROACTIVE

One key finding of the Piza et al. (2019) article is that "actively managed" CCTV systems are more effective. Passive systems are mainly useful for generating forensic images, one that can be used after the fact to identify possible offenders and offense details after an incident is reported by the victim or otherwise comes to light. Actively managed systems, on the other hand, require that someone is watching. This might be a security guard assigned to a parking lot or a team gathered around a wall of screens at a centrally managed facility. Employing people to watch screens to mobilize a rapid law-enforcement response obviously costs a lot more than does passively recording possibly useful images

during the course of countless hours of inactivity. In urban environments, many of which are now characterized by many thousands of cameras, the cost of actively monitoring cameras is a significant issue. Active management, however, was the vision of CCTV-based crime prevention reviewed in the National Research Council's recent report on proactive policing (Weisburd & Majmundar, 2018). The authors of the report acknowledge the presumed general deterrent effects of posting cameras in public places but stress that actively managed systems could have a two-fold advantage: They could dispatch police to the scene rapidly enough to disrupt events in progress, which could save lives or lead to the quick apprehension of fleeing offenders.

Speculating a bit on the future of CCTV, Piza et al. (2019) note there has been some progress toward the development of computer software that could take some of the drudgery out of CCTV monitoring while decreasing their passivity. Neural-network software could "learn" to recognize someone smashing a car window, the outbreak of a fight, or a purse snatching. The system would only have to be accurate enough at doing so to justify summoning the attention of a human supervisor, so it is easy to imagine this within the range of current technologies. Essentially it could convert CCTV to the equivalent of a timely 911 call. Traditional CCTV systems, however, remain mainly a "fixed post" surveillance technology, one further constrained by the fixed "viewshed" that they can surveil. In a built-up urban environment, viewsheds may be limited. New CCTV technologies, however, are emerging that promise to revolutionize this terrain. Further steps to activate CCTV systems have already been undertaken and are improving almost daily in effectiveness. These innovations include joining fixed-post cameras with acoustic detection systems that automatically reorient them toward any "action" that is within range. Other mobile CCTV devices actively monitor vehicular traffic. In addition, drones are being used to ferry cameras to selected locations for the purpose of providing overhead surveillance.

The best-known auto-steering camera system is vended by Shotspotter, Inc., a self-described provider of "precision-policing solutions for law enforcement." At this writing, Shotspotter claims to be active in 90 U.S. cities. Shotspotter systems couple fixed-base cameras with acoustic detectors capable of distinguishing between nearby gunshots and other routine city noises. When the software determines a sound is that of gunfire, the system analyzes its echoes and reverberations. The camera then rotates toward the calculated location of the gunfire. If this turns out to be in its viewshed (not guaranteed in an urban environment), potentially useful images can be recorded and simultaneously transmitted to a base station. In Chicago (which currently has more than 100 square miles of Shotspotter coverage), the images can also be monitored in real time by patrol cars in the vicinity. In addition, nearby officers have the capacity to take control of the camera from their car. The *promises* of Shotspotter include identification of locations of possible shootings that are more accurate than citizens are likely to be capable of conveying. It also promises more rapid response to shootings in public locations and the identification of shootings that currently go unreported by the public. The evidence for any of these claims is both mixed and sparse partly because Spotshotter Inc. contracts with cities typically precluding any use of the data for rigorous evaluation (Carr, 2017). Ratcliffe, Lattanzio, Kikuchi, and Thomas (2018) reported no evidence that previously unreported firearms incidents were being turned up by Shotspotter systems in Philadelphia; Carr and Doleac (2016) found some; Irvin-Erickson, Vigne, Levine, Tiry, and Bieler (2017) were more positive; plus, they found the technology places gunfire more accurately than does the information from matching 911 calls. Although expensive, the use of this technology continues to expand. Now, light poles manufactured by General Electric Corp. can be ordered with Shotspotter microphones built in at the factory. As I will discuss later, fixed-location but self-steering cameras will be a growth industry as the world moves toward "the Internet of Things."

Automated license plate readers are essentially highly mobile but single-purpose CCTV cameras; they do only one job, and well. Moreover, the cameras can easily be repositioned as part of evolving crime strategies. Parked along a busy arterial, a single patrol car equipped with a scanner can scan

upward of 1,000 plates per minute on vehicles passing by in either direction. This can also be done
at night using infrared lighting. Autonomous plate scanners can also be mounted at fixed posts. Their
gleanings are then transmitted to an analysis center, where plate numbers can be compared against lists
of those of interest to the police. These could range from the plates of stolen vehicles to lists of parking-
ticket scofflaws. Officers on the scene could potentially be notified if an action is required on the spot.
Plate numbers, the color (and perhaps the make) of the car, along with associated date and location
data, however, can also be stored for use in later investigations. They could be used to confirm the
presence of vehicles close to past or future crime scenes or to reconstruct the movement of vehicles of
interest around the city (Lum, Hibdon, Cave, Koper, & Merola, 2011). Plate data, in turn, are linkable
to detailed information on their associated owners through vehicle registration and driver's license
databases. Links could be made onward to person-based warrant lists, "strategic subject" or "high-risk
offender" databases, and departmental investigative alerts. Rental cars and trucks can be linked to their
current renter, which has proven useful in investigating truck bombs. Lum et al. (2018) reported that
two thirds of larger police agencies are using plate-reader technology, many of them extensively. For
example, after a spate of car-jackings in 2017, Chicago expanded its use of license plate readers, and the
equipment is now deployed in more than 300 police vehicles. Fixed-post readers are also stationed at
bridges as well as at entrances to gated areas around the city that present security concerns. In Camden,
New Jersey, *every* patrol car hosts a plate reader, and it runs around the clock (Wiig, 2018).

In parallel to license plate readers, traffic light monitors ("red light" cameras) and speed-detection
cameras can be found everywhere. These technologies were first introduced some years ago to automate
time-consuming but revenue-producing law-enforcement functions. There is an extensive evaluation
literature on speed and red light cameras in the traffic research domain. For example, in a British
study of speed cameras, the authors reported that, "Putting in another 1,000 cameras reduces around
1130 collisions, 330 serious injuries, and saves 190 lives annually, generating net benefits of around
£21 million" (Tang, 2017: 1). Findings of this magnitude reveal that traffic-oriented CCTV may well
be even more effective at saving life and limb than the CCTV projects examined in this report. It
is important to recall that law enforcement is a "public safety" function, and during 2017, 17,284
Americans were murdered but more than 40,000 were killed in traffic accidents. Many lives are at risk
daily on the traffic front, where the fundamental causes of concern are offenses involving speed and
alcohol.

Unlike traffic cameras, there has not been a systematic review of studies of the crime-prevention
effectiveness of strategies relying on license plate readers, and the findings of many individual stud-
ies have been mixed. In most evaluations, researchers have adopted hot-spots research designs that
are focused on small geographical areas. It is unlikely that the possible effectiveness of the larger
informational surveillance network, of which cameras are a part, will be identified. Much of what
turns up can be useful for reopening old cases, tracing associations between crimes across the
city, and for crimes taking place in the future. Research such as that conducted by Willis, Koper,
and Lum (2018) comprises discovering what agencies actually *do* with a piece of technology. This
research will be of continued importance because every aspect of surveillance technology is evolving
rapidly.

Less is known about the effectiveness of drone-based cameras, except that their flexible deployment
greatly increases the geographic scope of CCTV. Drone cameras are used extensively in emergency
management situations, including search-and-rescue efforts, hazardous materials incidents, monitor-
ing wildfires, and tracking the effects of natural catastrophes. As early as 2012, the New York City
police were using drones to track the buildup of crowds in tourist locations and flows of people partic-
ipating in demonstrations. They are, not surprisingly, widely used for traffic surveillance. Earlier these
assignments went to helicopter units, but drones are a considerably safer and vastly cheaper option

for deploying aerial cameras. They take little time to set up and deploy, and they are less visible and audible than aircraft loitering overhead. We should expect them to be used with increasing frequency. Replacing helicopters, drones will be more frequently detailed to hover over high-crime communities, contributing "eye in the sky" intelligence and "drone-assisted arrests" to hot-spots policing efforts. The image-gathering and processing capacity of drones has been driven by military applications, and as a result of this investment, the quality of data they gather has risen. This raises an issue discussed in a later section—the role of facial recognition software in CCTV systems. Mass-scale identification of specific individuals involved in political protests or mob action via drone-collected images may well be on the horizon. More immediately, whether policing drones will be weaponized—beginning with tear gas—will become a subject of public debate. Drones will certainly be commonly used by drug distributors and in other criminal enterprises, so camera-guided or even autonomous "drone on drone warfare" probably will become a feature of America's skies. (For an introduction to police use of drones in Britain, see Rogers & Scally, 2017.)

2 | CCTV AND FACIAL RECOGNITION

Facial recognition is the holy grail of the surveillance state, and it is certainly the most important technological advance looming on the horizon of CCTV. Facial recognition promises to "put names to faces" on a massive scale with enough accuracy to guide further investigations or to intervene in situations. The input typically consists of streaming video like that generated by traditional CCTV cameras. Image processing identifies the faces on view and enhances them for analysis. Like license plate readers, the software compares the resulting images with those of known persons. The known-persons database could include name-tagged police "mug shot" photos, driver's license and passport pictures, and even body-worn and dashcam video images that have been identified. Positive "hits" could trigger police action, or as with plate readers, identified images could be stored for possible future investigative use. They are a way of keeping track of who was where, and when. Outside of the policing world, there is a parallel explosion in the use of facial recognition by other public and private actors, often to keep untoward events from happening in the first place. Sports arenas monitor their entrances to identify known troublemakers, the Department of Homeland Security matches up the facial scans now taken of airport arrivals with its own databases, and pop performers scan their crowds for known stalkers.

There are certainly challenges to facial recognition, and imaging specialists are hard at work on them. The camera resolution and the angle at which images are recorded makes a difference in the accuracy with which faces can be identified, as does distracting paraphernalia such as beards and glasses. These and other issues are outlined by Mahmood, Muhammad, Bibi, and Ali (2017). Workable facial recognition systems, however, are not in the realm of speculation; they are a real product that is available at retail. Amazon, Inc.'s Rekognition software runs at its data centers. Currently, they charge $0.01 per month for each thousand name-tagged images they store for customers, and $0.10 per minute of video that Rekognition processes and compares to identified faces in the customer's image database. Amazon advertises that the software is continually trained on new data and is expanding in the scope of objects and activities that it can accurately recognize. Agencies like the New York Police Department use competing software from Microsoft and other vendors. Near the fringe of this technology lies the capacity of body-worn cameras to provide officers with real-time data on the persons they intersect with, and the continuous flow of data between the street and the control room promises increasing central coordination over field operations.

3 | CCTV AND THE INTERNET OF THINGS

The urban ecosystem that supports CCTV is expanding. In particular, the adoption of next-generation 5G wireless cellular technology calls for a vast expansion in the number of neighborhood transmission poles to compensate for its shorter transmission range. Alongside existing light and stoplight poles, these will provide numerous new places to position cameras. In Chicago, on-pole device clusters scattered around the city already sniff the air for pollution; report the temperature and noise level; and measure the concentration of carbon monoxide, particulate matter, and ozone. They share their poles with two cameras dedicated to assessing passing vehicle and pedestrian traffic, and, as I noted earlier, selected poles also host license plate readers. Overall, the city has ∼15,000 cameras on its network. On the newer poles, there are 5G connections among all of the devices and with home base. A map of these devices, which the city has dubbed its "Array of Things," provides documentation of the expansion of the surveillance network (arrayofthings.github.io).

In this discussion, I have excluded from consideration noncamera technologies of similar import that also hang on poles. The best-known commercial product in this line is the "Stingray," a device that sends signals tricking nearby cell phones into transmitting locational and other identifying information to law enforcement monitors. This includes IMSI numbers, which uniquely identify every cell phone in the world. This surveillance domain is exceptionally murky. As of November 2018, the American Civil Liberties Union had identified 75 law enforcement agencies that use the Stingray product, but it reported that "agencies continue to shroud their purchase and use of stingrays in secrecy" (aclu.org/map/stingray-tracking-devices-whos-got-them). Such devices could network with the CCTV-related equipment, and together they could constitute an even larger component of the surveillance state.

REFERENCES

Carr, J. B. (2017). Estimating the effects of police technology using quasi-experimental methods. *Journal of Benefit-Cost Analysis*, *8*, 360–368.

Carr, J. B., & Doleac, J. L. (2018). Keep the kids inside? Juvenile curfews and urban gun violence. *Review of Economics and Statistics*, *100*, 609–618.

Irvin-Erickson, Y., Vigne, N. L., Levine, N., Tiry, E., & Bieler, S. (2017). What does gunshot detection technology tell us about gun violence? *Applied Geography*, *86*, 262–273.

Lum, C., Hibdon, J., Cave, B., Koper, C. S., & Merola, L. (2011). License plate reader (LPR) police patrols in crime hot spots: An experimental evaluation in two adjacent jurisdictions. *Journal of Experimental Criminology*, *7*, 321–345.

Lum, C., Koper, C. S., Willis, J., Happeny, S., Novak, H., & Nichols, J. (2018). The rapid diffusion of license plate readers in US law enforcement agencies. *Policing: An International Journal*, *35*, 614–638.

Mahmood, Z., Muhammad, N., Bibi, N., & Ali, T. (2017). A review on state-of-the-art face recognition approaches. *Fractals*, *25*, 1–16.

Piza, E. L., Welsh, B. C., Farrington, D. P., & Thomas, A. L. (2019). CCTV surveillance for crime prevention: 40-year systematic review with meta-analysis. *Criminology & Public Policy*, This issue.

Ratcliffe, J. H., Lattanzio, M., Kikuchi, G., & Thomas, K. (2018). A partially randomized field experiment on the effect of an acoustic gunshot detection system on police incident reports. *Journal of Experimental Criminology*. https://doi.org/10.1007/s11292-018-9339-1

Rogers, C., & Scally, E. J. (2018). Police use of technology: Insights from the literature. *International Journal of Emergency Services*, *7*, 100–110.

Tang, C. K. (2017). *Do speed cameras save lives*? (SERC Discussion Papers, SERCDP221). London, England: Spatial Economics Research Centre, London School of Economics and Political Science.

Weisburd, D. L., & Majmundar, M. K. (eds.). (2018). *Proactive policing: Effects on crime and communities*. Washington, DC: The National Academies Press.

Wiig, A. (2018). Secure the city, revitalize the zone: Smart urbanization in Camden, New Jersey. *Environment and Planning C: Politics and Space*, *36*, 403–422.

Willis, J. J., Koper, C. S., & Lum, C. (2018). The adaptation of license-plate readers for investigative purposes: Police technology and innovation re-invention. *Justice Quarterly*, *35*, 614–638.

AUTHOR'S BIOGRAPHY

Wesley G. Skogan is an emeritus professor of political science at the Institute for Policy Research at Northwestern University. His research is focused on the interface between the public and the legal system—in crime prevention, victim services, and policing. He chaired the National Research Council Committee on Research on Police Policies and Practices and was co-editor of its report *Fairness and Effectiveness in Policing: The Evidence*. In February 2015, he testified before President Obama's Task Force on Policing for the 21st Century, on community policing. Prof. Skogan's other lines of research include neighborhood and community responses to crime, fear of crime, and the impact of crime on neighborhood life. He has been involved in research on criminal victimization and the evaluation of service programs for victims. He has twice testified before committees of the U.S. Congress on crime, fear, and victimization.