EVALUATING THE EFFECTS OF CCTV CAMERAS ON CRIME DISTRIBUTION IN BALTIMORE CITY

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ABSTRACT

This study investigates the effectiveness of public surveillance systems in the Cherry Hill neighborhood of Baltimore, MD to determine whether CCTV cameras are a successful crime control measure, or whether they simply displace crime to areas outside the camera’s viewshed. Previous research on the efficacy of CCTV have been inconclusive. The present study uses geospatial analysis to visualize and to measure crime distribution before and after CCTV installation. Results indicate that CCTV systems tend to eliminate concentrated hot spots of crime by dispersing criminal activity.

INTRODUCTION

CCTV cameras are currently used in the United States and in other part of the world (Skogan, 2004) with the intention of reducing criminal activity in large urban centers. Baltimore has a history of high crime rates which it has begun to address through one of the most extensive camera systems in the United States (La Vigne et al, 2011). Baltimore City's extensive use of CCTVs renders it a suitable candidate to determine whether there is a correlation between the implementation of CCTVs and a decrease in criminal activity. This study uses geostatistical techniques to characterize crime pattern alterations observed in CCTV camera viewshed areas in Baltimore. This investigation has the potential to greatly improve our general understanding of the role that CCTV devices play in crime control.

A closed circuit television (CCTV) system consists of either a fixed or mobile camera unit that can monitor and record criminal actions. Newer camera systems are usually equipped with high image quality and the ability to tilt, zoom, and pan with color recording and night vision (Gill et al., 2005). CCTV cameras are typically placed in areas which afford a good field of view. Strategic placement of cameras is often determined by examining crime patterns using geographic information systems (GIS) (Chainey, 2000). Mobile camera systems record motion imagery on a hard drive, which can later be downloaded for review, while fixed camera systems transmit images to a centralized monitoring location.

Although the first use of CCTV cameras to monitor criminal activity began in King’s Lynn, Britain in 1987, these cameras did not gain popularity as a tool in crime reduction until the 1990s. By 1997, CCTV systems were connected in over 300 towns and city centers in Britain and Wales (Harris et al.,1998). The U.K. invested over £100 million toward open-street CCTV monitoring systems between 1994 and 1997 (Norris and Armstrong, 1998). The number of CCTV systems grew in the U.K. from 5,200 units in 1997 to 40,000 units in 2002. This increase renders this initiative one of the most generously financed crime prevention measures in the U.K. (Welsh and Farrington, 2003). Gill and Springs (2005) study concluded that the effectiveness of
CCTV cameras in the UK cannot be deemed a success. Nevertheless, as evidence from the British study displays a distinct lack of confidence, it can be considered as an opportunity for further work in evaluation of CCTV in the USA (Ratcliffe, et al., 2009).

The United States has been much slower to adopt this technology. However, the use of CCTV surveillance has become more common, particularly after terrorist strikes in New York City in 2001. The availability of federal funding for homeland security has allowed many major cities, including Baltimore, to invest in CCTV technology as a measure to monitor crime activities and protect the citizens (FEMA, 2009). The implementation of the original federal funding was not based on previous studies, merely the idea of adapting to technology.

**Crime Cameras in Baltimore**

Baltimore has had a well-documented history of widespread criminal activity. In 1978, Baltimore Police Department reported 197 homicides, a number that then almost tripled by 1993 to 353 homicides. As recently as 2013, a total of 235 murders were documented in the city. At 0.4 incidents per 100 people, Baltimore’s rate of violent crime is far above the nation’s average (FBI, 2011). In 2003, Baltimore was ranked 7th in total violent crime in the United States, experiencing a total of 11,183 violent crimes and 48,653 total crimes (U.S. Dept. of Justice, 2004).

Although the Baltimore Police Department had experimented with video as early as 1995 (Nieto, 1997), widespread commitment to CCTV for crime prevention did not occur until Baltimore’s mayor visited London in 2004 and realized that public surveillance technology may help in crime solution and prevention (La Vigne, 2011). Currently, Baltimore has one of the most extensive camera systems in the United States. Since 1995 the city has spent over $16 million in acquisition, installation, and maintenance of the CCTV system. Most of the funding came from federal homeland security grants. The cameras are composed of both fixed- and hard-wired systems and portable units, or PODS (Police Observation Devices). PODS are camera units that can be easily moved around and set-up, but footage must be downloaded directly from each digital recording system for post-incident review and analysis (La Vigne et al., 2011). The fixed hard-wired systems, on the other hand, are mounted at certain locations and monitored by police officers from a centralized watch center. Officers at the watch center can zoom, pan, and follow a moving object.

**Crime Displacement and Diffusion of Benefits**

A recognized problem related to all manner of law enforcement efforts is that criminal activities might simply relocate to different places and times (Guerette, 2009). The movement of crime in time and space is defined as displacement (Repetto, 1976). Crime displacement is known as the transfer of crime starting from one target, place, time, or offense to another following some crime prevention initiative. For example, displacement may result from the presence of the crime prevention cameras in a target area (La Vigne, 2011). An argument against the use of cameras to reduce crime is that they simply cause a relocation of illegal activities to neighboring parts of town that are not under surveillance. Thus, one can argue that crime displacement to a new area occurs only as a result of the cameras’ lack of vision in said area (La Vigne et al., 2011).

When reduction in crime occurs outside the target area for crime prevention, diffusion of
benefits may also occur. Diffusion of benefits is a term used by criminologists to refer to the extension of the area that the crime prevention measure was originally predicted to affect (Dickerson, 2012). Thus, if there is a decrease in crime outside the CCTV crime camera’s surveillance area, it is classified as a diffusion of benefits. Studies are mixed concerning the observation of diffusion of benefits (Dickerson, 2012; Eck, 1993; LaVigne, 2011; Painter and Farrington, 1999; Polyner, 1992; Ratcliffe, et al., 2009).

**Study Methodology**

This study uses both descriptive and inferential geographical statistics to evaluate the spatial distribution of crime in Baltimore. These spatial characteristics are examined for crime data before and after CCTV installation to determine their effectiveness at crime prevention. Victim-based incident crime data for 2009-2015 was obtained directly from the Baltimore Police Department (BPD), while data for 2003-2009 was obtained from the Johns Hopkins University GIS library. The two datasets have nearly identical data and are highly cross-comparable. CCTV installation and functional data was also obtained from BPD, which was used in conjunction with USGS LiDAR data to determine absolute viewsheds for each CCTV installation.

The neighborhood of Cherry Hill was chosen for this study because it is a high-crime area with a high density of CCTV cameras. Cherry Hill’s population consisted of 96% African American in 2000 and 94.6% in 2010, compared to 64% in the city. Cherry Hill’s housing consists of low-income public housing, including the largest public housing development in the city. It is a dense urban residential neighborhood. The rate of non-fatal shootings per 10,000 residents in Cherry Hill for the years 2005 to 2009 is at 96.3, compared to the overall Baltimore city rate of 46.0 (Ames et al., 2011).

This study assesses the hypothesis that the presence of the CCTV crime camera decreases the rate of crime within the visibility of the cameras. An impact analysis test (weighted displacement quotient, WDQ) is used to examine the validity of the crime cameras in Baltimore City for crime distribution. This is supplemented by an optimized hot spot analysis and a viewshed analysis.

**Results**

Results from the WDQ are seen in Map 1 below and show that post camera installation, the reported crime incidents in the target buffer area (A) increased by 29 percent. The reported crime incidents in the buffer area (B) increased by 10 percent. In the control buffer area (C) the reported crime incidents increased by 53 percent. The success measure for the analysis was at -0.586. This means that the reported crime incidents in the target area were increased, but it performed better than the control area. The buffer displacement measure came in at -0.366 and a weighted displacement quotient (WDQ) at 0.624. Significantly, the buffer displacement and success measure indicate an effective scheme with a diffusion of benefits. It must be remembered that diffusion of benefits only occurs when there is a decrease of crime outside the camera’s surveillance area. This means that displacement buffer area (B) suffered proportionally less crime in comparison to the control buffer area (C) after CCTV implementation. Overall, the WDQ analysis determined that crime in the target area was higher.
Map 1: WDQ Analysis Before and After (Bottom) CCTV Installation
The viewshed analysis result layer was then used as a parameter to calculate the Getis-Ord Gi* Optimized Hot Spot Analysis. The results of the Getis-Ord Gi* optimized Hot Spot Analysis tool created a new feature class of the crime incident data, for pre- and post- installation of CCTV cameras. It was signified by whether it is part of a statistically significant hotspot, a statistically significant cold spot, or if it is not part of any statistically significant cluster (refer to Map 2). The red areas are hotspots, or areas where a high number of crime incidents have taken place. The cold spots would be the blue areas, but there are none on this map for the data. The beige areas represent a statistically insignificant cluster of crime incidents.

The magnitude of results from the Hot Spot Analysis can be visualized as a -0.50774 change rate in average magnitude (in comparing before and after CCTV implementation) outside of the camera’s viewsheds. In the viewsheds of the cameras, the average rate of crime increased with a value of 0.039368. The decrease in magnitude of crime incidences outside the camera’s viewshed after the installation is analogous to diffusion of benefits. The increase of magnitude inside the camera’s viewshed could be comparable to the WDQ results.
Discussion
As opposed to other similar studies, this research differs when displaying the evaluation of crime distribution from CCTV cameras. Most importantly, this study has obtained the exact view of sight of the crime cameras by using LiDAR data to calculate the viewsheds.

Results from WDQ analysis exhibit an increase of crime in the study area and a commensurate decrease in crime outside the camera viewsheds. The Hot Spot Analysis yielded similar results. Results of this study therefore indicate that CCTV installations are not highly effective in eliminating crime within their viewsheds.

Results of this study do indicate that it is possible to utilize CCTV installations to disperse crime throughout an area, as there was an observed tendency for large hot spots in the earlier period to be reduced in magnitude while newer, lesser concentrations of criminal activity have tended to occur.

It is possible that the increase in crime within camera viewsheds is observed simply because the CCTV system makes more criminal incidents detectable.

References


