System Assessment and Validation for Emergency Responders (SAVER)

Wide Area Persistent Surveillance Camera Systems Technical Report

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System Assessment and Validation for Emergency Responders

Prepared by Space and Naval Warfare Systems Center Atlantic

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FOREWORD

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercial equipment and systems, and provides those results along with other relevant equipment information to the emergency responder community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL). The SAVER Program mission includes:

- Conducting impartial, practitioner-relevant, operationally oriented assessments and validations of emergency responder equipment; and
- Providing information, in the form of knowledge products, that enables decision-makers and responders to better select, procure, use, and maintain emergency responder equipment.

Information provided by the SAVER Program will be shared nationally with the responder community, providing a life- and cost-saving asset to DHS, as well as to Federal, state, and local responders.

The SAVER Program is supported by a network of Technical Agents who perform assessment and validation activities. Further, SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

As a SAVER Program Technical Agent, the National Institute for Standards and Technology (NIST) provides expertise and analysis on key subject areas. NIST conducted an assessment of wide area persistent surveillance (WAPS) camera systems and digital high-definition (HD) cameras. WAPS camera systems and digital HD cameras fall under the AEL reference number 14SW-01-VIDA titled Systems, Video Assessment, Security. The results of this assessment are provided in this report.

Visit the SAVER section of the Responder Knowledge Base (RKB) website at https://www.rkb.us/saver for more information on the SAVER Program or to view additional reports on WAPS camera systems, digital HD cameras, or other technologies.

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1. OVERVIEW

In July 2012, an assessment of wide area persistent surveillance (WAPS) camera systems and digital high-definition (HD) cameras was conducted in a multi-acre Federal site in the Washington, DC, area. The purpose of the assessment was to provide general information to law enforcement agencies that are considering employing and/or purchasing this technology.

2. BACKGROUND

In general, WAPS camera systems have the ability to surveil a specific region in order to increase the opportunity to detect and observe activities, identify entities involved, and track events forward in real time or backwards forensically. These systems typically include a high-resolution camera with a wide-angle lens, and a video recording system (e.g., digital video recorder [DVR] or network video recorder [NVR]) to capture and review the video footage. While the camera system may have pan-tilt-zoom (PTZ) capabilities, the system is not used in a PTZ configuration in order to prevent disruption to the field-of-view or to the continuity of coverage. A WAPS camera system can stand alone or it can be integrated into a separate closed circuit television (CCTV) monitoring system.

From a law enforcement perspective, the main benefit of a WAPS camera system is to maintain a continuous record of events for a given area of coverage. There are several reasons for this persistent requirement:

- It provides a start-to-finish record of the entire event for full awareness and understanding of what occurred and where, when, and how the event unfolded.
- It ensures no loss of coverage due to a misdirected PTZ unit or fixed camera coverage not in place.
- It offers a clean, unedited product that can be more easily validated and trusted as a true record of the activity. Courts have long been leery of the manipulation of video evidence; legal evidence for court related actions must be unretouched and is preferably a single continuous clip of video.
- It provides high-resolution imagery to enable identification of persons, objects, and vehicles.

Law enforcement agencies commonly surveil: public events such as outdoor concerts and street festivals, high-traffic pedestrian locations, and known criminal activity locations. WAPS camera systems can be permanently installed in a fixed location or used in a temporary location, and used during overt or covert operations.

3. ASSESSMENT METHODOLOGY

In order to perform a comparison of different camera technologies, formats, and capabilities, several standard digital HD cameras, digital megapixel cameras, and WAPS camera systems were selected for assessment. Specific selections were limited due to equipment availability, but the units assessed were representative of standard industry offerings at the time of the assessment.

All camera systems were placed with approximately the same camera angle and view for comparison purposes. The systems were set up at a predetermined distance that was not altered from the area to be monitored, in order to provide persistent coverage. Video footage from each camera was captured for 3 to 5 minutes at specific times throughout the day to assess the effects of lighting and sunlight on the functionality of each camera system. The times of video capture were: 10:00, 13:00, 16:00, 19:00, dusk (approximately 20:45), and 22:00.

Seven law enforcement officers with experience using video surveillance systems served as evaluators for this assessment. All evaluators had at least 5 years of law enforcement experience. During the assessment, the evaluators rated the digital HD and digital megapixel cameras and WAPS camera systems based on their knowledge of the areas being assessed, awareness of the overall goals of the assessment, and familiarity with the existing video systems in use. Their assessment included perceived quality of picture, field-of-view, operational usefulness, and zooming capabilities.

4. RESULTS

The WAPS camera system that was rated excellent by the evaluators based on the optical zoom levels and detailed imagery at long range had the following capabilities and specifications:

- 35x optical zoom and 12x digital zoom, 220°-tilt, full PTZ dome unit
- D1 resolution (720x480)/high-Power over Ethernet (PoE)
- H.264/Motion Joint Photographic Experts Group (M-JPEG) and Open Network Video Interface Forum (ONVIF) compliant
- Lens specifications: f = 3.4 to 119 millimeters (mm), autofocus and automatic day to night switching
- Horizontal angle of view: 55.8° to 1.7°
- Vertical angle of view: not applicable
- Image sensor: 1/4-inch ExView progressive scan hole-accumulation diode (HAD) charge-coupled device (CCD)
- Shutter time: 1/30,000 second (s) to 0.5s.

The digital HD cameras that were rated excellent by evaluators based on resolution, image quality, color quality, and frame-rate had the following capabilities and specifications:

Camera A

- HD resolution (1080i/720p/16:9 ratio/30 frames per second [fps]) and PoE
- H.264/M-JPEG and ONVIF compliant
- 10x optical zoom and 12x digital zoom
- Lens specifications: f = 5.1 to 51 mm, autofocus and automatic day to night switching
- Horizontal angle of view: 48.1° to 5.1°
- Vertical angle of view: not applicable

- Image sensor: 1/3-inch, 2-megapixel progressive scan complementary metal-oxide semiconductor (CMOS)
- Shutter time: 1/30,000s to 0.5s.

Camera B

- HD resolution (1080p/16:9 ratio/3 megapixel/30 fps) and PoE
- H.264/M-JPEG/Moving Picture Experts Group (MPEG)-4 and ONVIF compliant
- Wide view (fisheye type lens)
- Lens specifications: f = 5.1 to 51 mm, autofocus and day and night functions
- Horizontal angle of view: 31.7° to 93.0°
- Vertical angle of view: 23.8° to 68.4°
- Image sensor: 1/3-inch, 1,600- x 1,200-resolution CMOS
- Shutter time: 1/5s to 1/40,000s.

5. RECOMMENDATIONS

Key points to keep in mind when evaluating and purchasing a WAPS camera system:

- There is a trade-off in frame-rate for overall picture quality (i.e., very high resolution equates to very slow frame-rate).
- A digital HD camera with PTZ capabilities can offer higher zoom capabilities than most WAPS camera systems; however, PTZ units do not offer persistent coverage and do not have a wide field-of-view.
- If facial recognition from a WAPS camera system is needed, the system must be placed close enough to obtain the necessary resolution or, alternatively, use both a PTZ unit and a WAPS camera system to cover this requirement.
- Obstructions can severely impact the field-of-view with any camera technology, so a site survey and location sampling is vital to the camera's placement and effectiveness.
- There are strict guidelines regarding forensic video if it is to be used as evidence in court, so it is necessary to identify and follow the guidelines as published by the Federal, state, and local law enforcement and court system.

6. CONCLUSIONS

The placement of a WAPS camera system might appear obvious, but wide-angle view and depth-of-field can cause several issues. One major problem is the existence of obstructions. Trees, shrubs, buildings, vehicles, and other permanent or temporary obstructions can severely impact the actual viewing area of the camera. Also, the distance to the target can be a constraint based on the focal length and the sensor size of the cameras used in regards to image quality (if one can detect, classify, or identify a target). A major concern with a longer zoom lens is the

loss of overall width-of-field. It is easy to extend the length of the zoom, but at a substantial loss in the width-of-frame. The location of the camera must take into account all of these factors, as well as basic power and network connectivity needs, which are always factors in camera placement. In the end, a balance must be established that fits the constraints of infrastructure connectivity, while providing the desired view and coverage. More than one camera may be required to provide the desired coverage.

A typical approach for camera placement is to use a floor plan or outdoor map to plan for initial camera locations. While this approach provides a good starting point, it is necessary to assess camera systems in their proposed locations prior to installation. There are usually obstructions that will be identified during a site survey that were not included on any drawing or map. A prime example is foliage, particularly seasonal foliage. Many trees and shrubs will lose their leaves in the fall and winter seasons allowing camera systems a greater area of coverage than in the remainder of the year. Pedestrian and vehicle traffic, fencing, and gates are also common obstructions to a desired view. Following a site survey, video of each location can be used to verify suitable locations prior to any installation or procurement expenditures. Most camera manufacturers or vendors will provide a demo unit for the site survey and many will perform the site survey alongside the consumer to ensure proper performance.