SURVEILLANCE AND SECURITY TECHNOLOGIES FOR BRIDGES AND TUNNELS

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ABSTRACT

The Federal Highway Administration initiated a national pooled fund study in 2003 to synthesize technologies for bridge and tunnel surveillance and security. In the months following the September 11, 2001 terrorist attack, the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB) jointly conducted a security and emergency response survey of all State DOTs to help them assess vulnerability and preparedness. The results of this survey indicated that 59% of the respondents had some surveillance capabilities on their bridges. The State transportation agencies and other private bridge owners were seeking options for increasing surveillance and security of vulnerable structures. Yet, they were being overwhelmed by new technologies, and the lack of guidelines to choose between these technologies. The State highway agencies needed better information on cost, effectiveness, design and applicability of *state-of-the-art* technologies for protecting bridges and tunnels. This paper presents a summary of the completed work soon to be published by the FHWA as Report No. FHWA-HRT-05-082, 'Bridge and Tunnel Security and Surveillance Technologies.

INTRODUCTION

Background

Following the September 11, 2001 terrorist attack, the State transportation agencies and other private bridge operators (e.g. railroads) were seeking options for increasing security of vulnerable structures. Information was lacking on cost, effectiveness, design and applicability of *state-of-the-art* surveillance and security technologies for protecting bridges, such as closed circuit cameras, electronic detection, monitoring, tracking and alarm systems, or security patrols. Recognizing this gap, the Federal Highway Administration initiated a national pooled fund study to synthesize state-of –the-art in bridge and tunnel surveillance and security technologies. Joining the FHWA were the state departments of transportation of California, Kentucky, Missouri, New Hampshire, New Jersey, New Mexico, Ohio, and Texas.

The state-of-the-art technologies for bridge and tunnel surveillance identified in this study is intended to assist the States in decision making and provide guidelines to determine the benefits of new technologies with the ultimate goal to improve existing levels of security.

Scope of Study

The goal of the study was, by synthesizing the latest technologies and practices, to develop evaluation frameworks, tools, and techniques to select among alternative surveillance and security approaches consistent with vulnerability levels. Secondary goal was to evaluate and recommend opportunities to maximize the value of these technologies by ensuring multiple uses (i.e. ITS/traffic management uses, bridge condition monitoring, multiple-hazard monitoring). It was intended that the study pay particular attention to differences between large, densely populated states and smaller, rural states in terms of needs, capabilities, and appropriate technologies.

RESEARCH APPROACH

Literature review of all available surveillance and monitoring systems and technologies was conducted both within the US and abroad. Literature search was performed for current technologies as well as emerging technologies being developed not only in US but also foreign countries such as China, Russia, and Germany. Also, security and surveillance conferences were attended to obtain the latest information on current and emerging systems. Search was also performed for sensor systems being used by Department of Defense as well as other federal agencies.

A survey of bridge owners was conducted on their surveillance and security capabilities. The research team also made site visits to several bridge sites to record existing capabilities and discuss with the owners their satisfaction, etc. of the equipment and procedures in place. In an effort to assist the bridge owners select and assess products and technologies a database of available security and surveillance system has been developed.

FINDINGS

Literature Review

The latest systems available on the market today are in most cases a direct result of technological advancements on many fronts. Issues such as power consumption, size, ruggedness, and cost have all been addressed by private industry and the military for various applications. Most prominent are integrated threat detection systems and technologies. These systems utilize a large array of components, each performing a small job to support the whole system. Many times these components “overlap” in their abilities thus, providing a level of “backup” protect.

Extended sampling capability is not the only advantage of these systems. They also decrease the strain on human workforce to monitor the extra capabilities. A “silence is security” posture is allowing greater resource efficiency. The system is tasked with monitoring and will alert the operator when an event occurs which is much faster, secure, accurate, cost effective and

thorough than having the operator monitor for events. Systems such as these are being deployed at a rapid pace to combat terror threats in airports, train stations, bus stations, locations for summit meetings, and for protecting borders. These systems are also used extensively by the military for base security.

Survey and Site Visits

With the assistance of the American Association of State Highway and Transportation Officials (AASHTO) a web survey was conducted to gather information on technologies being used by owners. The survey was sent to 63 AASHTO members. It consisted of 44 questions and in addition comments were requested. Based on a 75% response rate, 25% of the respondents indicated they had an overall security and surveillance program for bridges and tunnels, although 59% stated that they give high priority to security of bridges and tunnels. The 25% number is much less than the initial AASHTO survey where 59% indicated they had some surveillance capabilities on their bridges. It is unclear, why the numbers varied as much. Of those responding positively, 53% had security systems on their bridges and 24% on their tunnels. Regarding the question on whether the states utilized their systems for purposes other than security, thirty one percent responded positively that they use the system in addition for intelligent transportation use, traffic management, etc. No one indicated they use the system for condition monitoring of their structures.

Figure 1 shows the systems currently in place based on the survey. Majority of the surveillance security sensor systems consist of humans, video cameras, fences and lighting. These systems detect vehicles, pedestrians, and boats in and around structures. Only 8% of the respondents stated that they can detect swimmers.

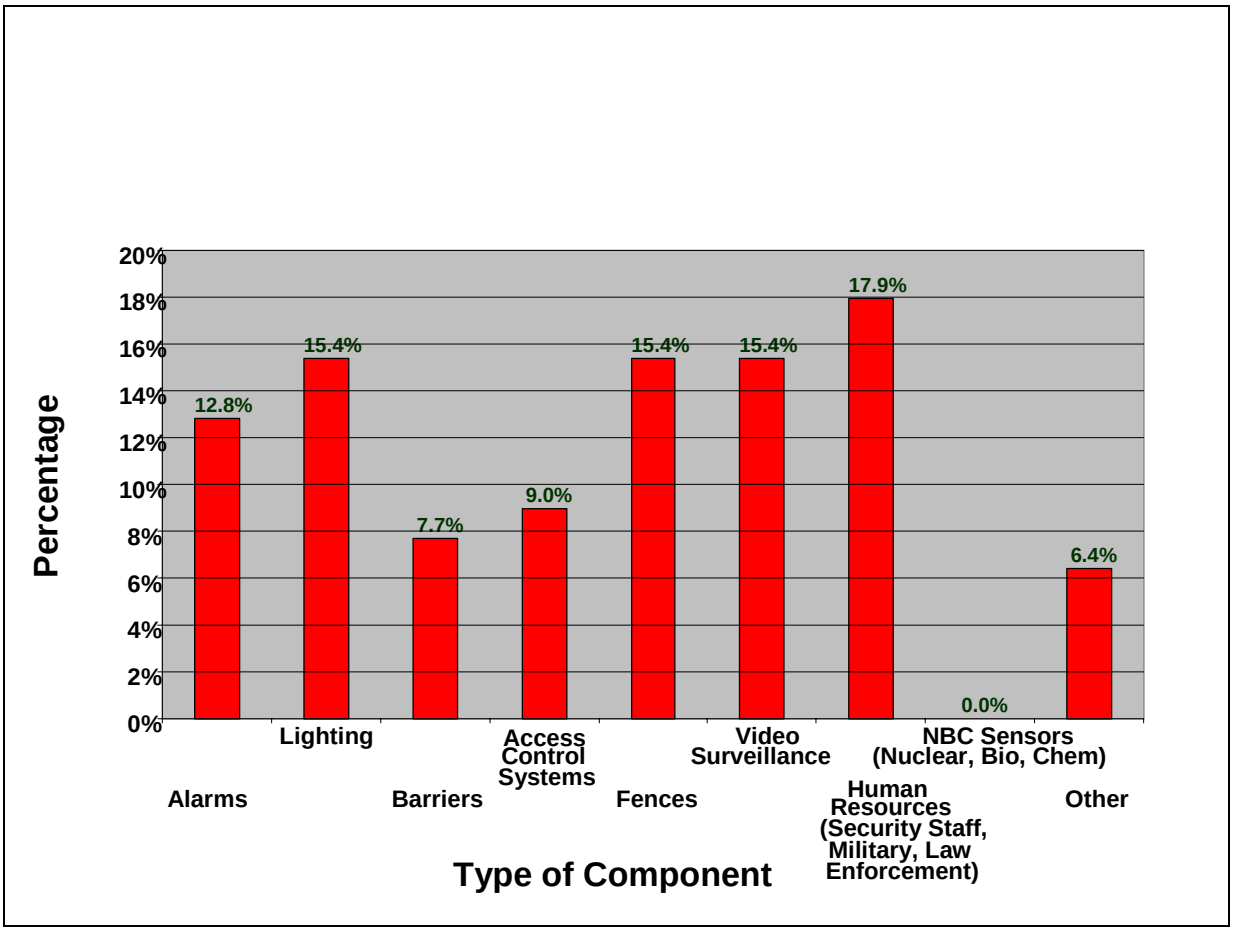

Figure 1: Types of Components Used in Surveillance Security System

Seventy-one percent of the respondents indicated they have had custom-made security systems for their bridges and tunnels. Regarding cost, 57% stated that they have spent over $100,000 for security systems, and 31% spent over $50,000 per year for maintenance of bridges and tunnels. The survey indicated 31% intend to upgrade their security system in near future, and 50% intend to integrate surveillance systems in the design of new structure.

The results of the survey give a good indication of the state of the practice of bridge owners as to surveillance and security technologies deployed (or lack of) on their structures. Follow-up telephone discussions with several State DOT officials provided additional information and clarity to some of the questions. The project team also visited several owners to collect information on their existing systems.

After 9/11 owners with critical structures were given orders to provide security and surveillance systems to protect their structures. However, with little guidance available, lessons continue to be learned in a costly manner. Some states have designed and installed systems superior to other sites, but some security threats are still not being addressed.

Any system installed must perform in the harsh environments, and for continued length of time. Some owners have had the luxury of conducting tests to insure performance under all service

conditions, however long term performance is lacking. In addition with rapid changes in technology, any system deployed needs to have the flexibility for easy adaptation to the changing information technology field.

The systems that were seen during site visits were:

- Pan-Tilt Zoom cameras with optional infrared illuminators
- Analog/digital video encoders
- Wireless bases
- Wireless point-to-point dishes
- Motion detectors
- Digital video recorders
- TCP/IP communication structure
- Customized software for manipulation and prioritization of field components.

Most of the systems were separate from traffic management systems, although the Traffic Management Centers (TMC) were utilized for the security setup, and the same systems could be used for both applications. Some of this was due to the legality of sharing information. The operation and management of the systems varied from locality to locality. Local law enforcement in some states had legal authority to manage and enforce decisions, while in others this was done by the State highway agencies.

Perimeter control is usually the first layer of security. Some had strong access control systems in place to prevent unauthorized access. Even with security cameras in place however, incidents have occurred. In any case, quick response is critical. Some bridge sites had onsite towing for cases where vehicles were stopped on the structure, and some had their own fire trucks.

The following represent some of the issues encountered during site visits:

- Right of way issues in installation of supporting systems for the security systems.
- Lack of qualified testing facilities for vendor products.
- Authority of data retrieved and sharing of information.
- Difficulty in installation of security components especially on highly traveled and/or complicated structures.
- Maintenance issue with cameras including bird droppings and moisture accumulation, and accumulation of smoke on lens covers, especially in tunnels.
- Concerns in areas with earthquake or severe movement of structures.
- Access to equipment, which varied to from being easy to hard to access.
- Detection of underwater targets not being considered.
- Lack of cooperation between authorities for placement of equipment and supporting systems.

Database

A database of available security and surveillance systems providing information on existing sensors was developed. Investigations were conducted on the COTS sensor systems such as video cameras, motion detectors, alarm systems, fences, Nuclear-Biological-Chemical (NBC)

sensors, microphones, fiber optics sensors, Infrared cameras, seismic sensors etc. The database and checklist was developed for 30 different types of sensors. The database contains cost, manufacturer's name, and performance in various environments. It also includes a checklist to assist in acquiring proper information for evaluation of a particular system. It has become very clear that most states do not have the capability or resources to select systems for their particular bridges or tunnels. For example, there are hundreds of vendors manufacturing video cameras in the market, and reviewing the specifications of each camera is very time consuming and requires great deal of technical knowledge for evaluation.

SUMMARY AND RECOMMENDATIONS

Based on the work conducted it is very clear that the State DOT's lack funds for acquiring the latest technologies, and for selecting proper systems and integrating the systems for their use. In addition, there is a need for improved cooperation among federal, state, and local government agencies to provide best system for surveillance and security.

An ideal system should have the following characteristics:

- A video system with recognition capability to identify and separate hostile actions (person stops car, gets out, leaves package) from innocent ones (person stops car, gets out, changes tire).
- A system that is alarmed based, so the data gets displayed on screen only in case of unusual activity.
- A system designed with flexibility in mind for incorporation of future technologies.
- A system populated with various sensors not only for above ground detection, but also underwater detection and identification.
- A system with low false alarm rates.
- A system designed for all hazard warning, and which can be used for structure condition monitoring and for everyday traffic operations.
- A system which incorporates sensors to determine remaining structural capacity after an event.
- A wireless system to eliminate the cost of installing cables for long distances.
- A system that's low cost, virtually maintenance free, and easy to use.

The study recommends a demonstration be done on a network of bridges and tunnels with the latest low cost technologies which showcases total integration of all of the sensor systems.

The database developed is a static system, which can quickly become obsolete with rapid changes is technology. The sensor technology is improving at fast rate, leading to new models with new capabilities and lower cost. Therefore, the study also recommends the database be converted to a web based concept where the vendor would be able to update the sensor systems as soon as new products are developed. This approach will permit the State highway agencies to get the latest technology for their system.

The final report for this study will be published by the FHWA titled 'Bridge and Tunnel Security and Surveillance Technologies, Report No. FHWA-HRT-05-082. It should be available in the summer of 2006.