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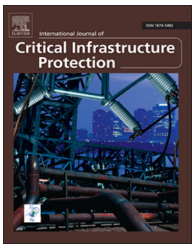

Integrated roadmap for the rapid finding and tracking of people at large airports

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ABSTRACT

This paper presents an integrated roadmap for the rapid finding and tracking of people at large airports. Business continuity at an airport is threatened by incidents such as left luggage and breaches of secure areas. These activities require rapid response because they are high frequency, high risk and high cost. For these reasons, live tracking and forensic searches of people are important tasks, for example, finding the owner of a left piece of luggage or tracking a trespasser. Finding and tracking people using surveillance cameras without technical aids is time consuming. The roadmap for the rapid finding and tracking of people at airports is based on discussions with end users, an assessment of the state-of-the-art and an integral assessment of work processes, human–machine interfaces, computer vision and the information and communications infrastructure. According to the roadmap, a major step forward can be achieved by integrating advancements in four areas: (i) increasing camera coverage; (ii) implementing computer vision for automated recognition and tracking; (iii) using contextual user interfaces; and (iv) adapting training and work processes to the tasks of finding and tracking people.

1. Introduction

Large airports are complex critical infrastructures that involve high stakes for the national economy and the safety of people working, visiting and transiting the airport. Airports formulate strategic business goals in terms of the number of passengers, airport reputation, security and personnel costs, etc. These business goals can be ultimately translated to the need to control and mitigate the risk factors that negatively impact airport business continuity and reputation.

The security of an airport is constantly affected by incidents that could potentially grow to be a threat to business continuity (e.g., a large-scale evacuation). Examples of frequent incidents are left luggage, trespassing in secure areas, pickpocketing, shoplifting, swindling, drug dealing and harassment of airport personnel or members of the public. Less frequent, but more significant, incidents include hijackings, bombings, shootings, robberies and terrorist acts. When an incident causes an evacuation or a perimeter to be established that includes airline gates, the continuity of air traffic is affected and the chain of events potentially impacts business continuity at other airports. It may take days, sometimes even weeks, before all the delayed passengers and their luggage are handled. The actual costs depend on factors such as flight frequency, airlines, presence of alternatives and percentage of affected flights. A rough estimate is

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that a single incident may cost millions of euros distributed over multiple companies and it may damage the reputations of the airport, carriers and air travel, in general. Apart from the less frequent large-scale incidents, frequently-occurring small incidents impose significant structural pressure on security departments at airports.

Airport security personnel dedicate a substantial portion of their time to searching and tracking people in order to prevent and respond to incidents. The more time it takes to find a person of interest after an incident is detected, the more complex the search becomes because the area to be searched increases with time. Many security organizations use closed-circuit TV (CCTV) systems to help assess, prevent, mitigate and respond to incidents. However, addressing incidents in an effective manner requires more than simply purchasing expensive equipment [16]. Policy makers, airport management and suppliers need an understanding of the investments required to accomplish the joint strategic goals. Therefore, it is important to understand the maturity of the technologies and if they are ready for operational use. Acquiring this understanding before the competition can give an airport significant competitive advantages.

This paper attempts to answer three questions. How can airport security at a large civilian airport find and track people faster? How can this contribute to strategic business goals? How mature are the available technologies and what technologies are feasible in the short and long terms?

Researchers have developed automated techniques for tracking [4], recognition [3,18] and other aspects of identifying persons of interest in CCTV footage. However, they do not provide an integrated overview of the various solutions for finding and tracking people at an airport and a plan that matches the maturity of the solutions with short-term and long-term goals. Researchers have also created roadmaps for generic airport security [14]. However, these roadmaps are typically at a high level of abstraction. The roadmaps may cover a wide range of topics, but the level of abstraction forces them to omit many aspects that are relevant to finding and tracking individuals.

The novel contribution of this paper is an integrated roadmap geared towards the rapid finding and tracking of people at airports while maintaining the same or higher levels of security. The roadmap focuses on work processes, human–machine interaction, computer vision technologies and the information and communications technology (ICT) infrastructure. The roadmap distinguishes between technologies that can be used within one year, those that can be expected in the near future (three years) and those that are anticipated in the long term (beyond five years).

2. Roadmap creation

A technology roadmap is a plan that matches short-term and long-term goals with specific technological solutions. The content of a roadmap is determined by four aspects: (i) starting point; (ii) desired end condition; (iii) external factors; and (iv) scope. Only after all these aspects are determined can the internal structure and content of the roadmap be determined. This section describes the methodology used to obtain the roadmap. Next, it describes the four aspects that determine the content of the roadmap and elaborates on the use cases. Finally, it presents the main components of the roadmap.

2.1. *Methodology*

Three steps were used to obtain the roadmap described in this paper. First, the frequency and impact of incidents were determined in collaboration with the Dutch Military Police and Schiphol Airport Security. This study resulted in the selection of the use cases described later in this section. Second, information was gathered about the organizational processes at Schiphol Airport by interviewing experienced security and airport services personnel about the most relevant use cases, the current working process, interfaces and technologies. Third, technology-related information was collected by consulting experts in the fields of information and communications technologies, computer vision technologies, human factors, and behavioral and social sciences. This enabled the creation of a survey of relevant research and state-of-the-art commercial products.

The usability of a technology depends on the performance of the technology and the circumstances in which it is used. Existing technology can be tested in realistic environments by users. However, the prediction of future technological developments requires input from specialists. A questionnaire was formulated to obtain assessments from computer vision experts to underpin the time estimates in the roadmap. This way, deep insights into the obvious and uncertain aspects of technological developments were obtained. Although the responses to the questionnaire may be biased (possibly, too optimistic or too pessimistic), it is clear that the relative maturity of technologies could be assessed reliably by the participating experts.

2.2. *Aspects that determine roadmap content*

The content of a roadmap is determined by four aspects: (i) starting point; (ii) desired end condition; (iii) external factors that may influence the roadmap; and (iv) scope of functionality that it should cover at certain points in time. Only after all these aspects are determined can the internal structure and actual content of the roadmap be determined.

The starting point in the roadmap is a fictional large airport that is similar to many existing airports. At the airport, several organizations and teams are involved in finding and tracking people, for example, border/military police, customs and airport personnel [20]. Multiple surveillance teams operate among the public without access to CCTV footage. Each organization has its own camera surveillance room with camera operators. When personnel in the field need to locate an individual, a call is made to the appropriate camera surveillance room with a search query comprising the person's description, time, place and/or behavior. Control and coordination for finding and tracking people are centralized. The user interface of the surveillance system is a video wall with multiple feeds. Computer vision technology that analyzes video content is not used. A secure fixed IP network is in place for transporting digital video data, but a