



Review Article

Application of forensic image analysis in accident investigations

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ARTICLE INFO

Article history:

Received 4 April 2017

Received in revised form 7 June 2017

Accepted 30 June 2017

Available online 8 July 2017

Keywords:

Image analysis

Forensics

Accident investigation

ABSTRACT

Forensic investigations are primarily meant to obtain objective answers that can be used for criminal prosecution. Accident analyses are usually performed to learn from incidents and to prevent similar events from occurring in the future. Although the primary goal may be different, the steps in which information is gathered, interpreted and weighed are similar in both types of investigations, implying that forensic techniques can be of use in accident investigations as well. The use in accident investigations usually means that more information can be obtained from the available information than when used in criminal investigations, since the latter require a higher evidence level.

In this paper, we demonstrate the applicability of forensic techniques for accident investigations by presenting a number of cases from one specific field of expertise: image analysis. With the rapid spread of digital devices and new media, a wealth of image material and other digital information has become available for accident investigators. We show that much information can be distilled from footage by using forensic image analysis techniques.

These applications show that image analysis provides information that is crucial for obtaining the sequence of events and the two- and three-dimensional geometry of an accident. Since accident investigation focuses primarily on learning from accidents and prevention of future accidents, and less on the blame that is crucial for criminal investigations, the field of application of these forensic tools may be broader than would be the case in purely legal sense. This is an important notion for future accident investigations.

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1. Introduction

Accident investigation¹ is focused on understanding the events leading to an accident and on drawing lessons that can prevent accidents from occurring in the future. The central question that is answered when accidents are studied is “*What went wrong?*”, and “*How can we prevent similar accidents from occurring in the future?*”. The outcome of such an investigation is usually a set of lessons learnt, or recommendations to the organisation involved.

Over the past decades, accident investigation has developed from event-driven investigations aimed at finding design flaws, toward more broadly scoped investigations on a range of topics [23,20]. In the process of unravelling the chain of events that resulted in an accident, a variety of methods can be used. The research techniques that are used vary from qualitative methods such as interviews and document search to more quantitative methods such as simulations, model calculations or statistical analysis [12].

Criminal investigation refers to the process of collecting information (or evidence) about an incident in order to determine whether a crime has been committed, to legally obtain information and evidence to identify the responsible person, to arrest the suspect, to recover stolen property and to present the best possible evidence. If these objectives are successfully attained, then the crime can be said to be solved [5,6]. Criminal investigations focus on the answer to the question “*Who is guilty?*” or “*What criminal offence took place?*”. The outcome of a criminal investigation is, ideally, a conviction or punishment.

From this definition, it is clear that criminal investigation usually involves the study of (large amounts of) data and factual information, usually referred to as ‘traces’. Many different types of traces can be present, e.g. human and biological material, chemical residuals or digital information. In order to analyze the available traces, criminal investigations commonly employ many state-of-the-art scientific techniques known collectively as forensic science. The fact that the outcome of a criminal investigation may contribute to a conviction sets high standards on the accuracy, repeatability and objectiveness of forensic methods, and much effort is spent on the validation of new methods. This need for high forensic standards has become even more apparent during the last two decades, after the discovery of a number of high-impact judicial errors leading to wrongful convictions. See, e.g. the large number of publications that were prompted by the “Schiedammer

Parkmoord” in the Netherlands, after which major revisions in the Dutch criminal prosecution process were effectuated. Since then, investigators are increasingly aware of potential pitfalls such as tunnel vision and hindsight bias. Similar initiatives have taken place in the US, e.g. by the [18] PCAST group. This increased awareness implies that it may take years before the result of new forensic methods reaches a high enough evidence level to be useful in a court of law (see, e.g., the historical development of the use of results of DNA-analysis within criminal investigations, [13]).

Clearly, both types of investigation take place in a different context.² Performing an investigation to obtain lessons and learning places different emphasis than when trying to find the perpetrator of a crime. However, the process that is followed during both types of investigation shows many similarities. To illustrate this, a more schematic overview of the investigation process that is followed in both criminal and accident investigation is outlined in Fig. 1 below.

Central to both investigations is the step in which data is collected, weighed and interpreted, leading to an impression of the circumstances in which the accident happened. In criminal investigation, this step is done by using forensic methods that pertain to high standards, as was pointed out in the previous paragraph. In accident investigation, a more general toolbox of both quantitative and qualitative tools is employed.

Not very often, the gap between methods employed by accident investigations and those used in forensic investigations is bridged. A priori, it is expected that this is the case because of their different field of application. However, the wealth of methods available from the forensic field, and the rapid developments that take place in this field invite accident investigators to cross the bridge and determine the applicability of forensic methods in accident investigations. One aspect that is worth investigation in doing this, is whether the high standards on which forensic methods are based, may be loosened when applying on accident investigations, and whether this opens up more possibilities.

As a powerful demonstration of this principle, in this paper, we present a number of cases that illustrate the applicability of forensic tools in accident investigations. We selected cases from one specific field of expertise, (digital) image analysis, because they provide an interesting illustration of the wide range of applicability as well as the limitations of the available techniques. We also discuss the effect of the different standards that play a role in both fields and show that this may imply that a forensic method is too labor-intensive to be useful for accident investigations. On the other hand, we also show that specific techniques can be more readily useful in accident investigations than in criminal investigations.

¹ In this paper, we focus on accident investigations performed by governmental institutions such as inspections, ad-hoc committees or accident investigation boards. These investigations have in common that they are focused on obtaining lessons and are not focused on blame, penalty or conviction. Notice that private parties such as insurance companies may perform accident investigations as well, but such investigations are usually performed within a different context and are focused on other goals. They therefore fall outside of the scope of this paper.

² Notice that the outcome of an accident investigation may in some cases lead to or be used in a criminal investigation. In the Netherlands, this situation is excluded by law, but this is not always the case in other countries.

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