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An innovative and shared methodology for event reconstruction using images in forensic science

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ABSTRACT

This study presents an innovative methodology for forensic science image analysis for event reconstruction. The methodology is based on experiences from real cases. It provides real added value to technical guidelines such as standard operating procedures (SOPs) and enriches the community of practices at stake in this field. This bottom-up solution outlines the many facets of analysis and the complexity of the decision-making process. Additionally, the methodology provides a backbone for articulating more detailed and technical procedures and SOPs. It emerged from a grounded theory approach; data from individual and collective interviews with eight Swiss and nine European forensic image analysis experts were collected and interpreted in a continuous, circular and reflexive manner. Throughout the process of conducting interviews and panel discussions, similarities and discrepancies were discussed in detail to provide a comprehensive picture of practices and points of view and to ultimately formalise shared know-how. Our contribution sheds light on the complexity of the choices, actions and interactions along the path of data collection and analysis, enhancing both the researchers' and participants' reflexivity.

1. Introduction

Currently, photographs and videos are omnipresent. A device for recording images is available in everyone's pocket. The resolution of compact and mobile phone cameras continues to increase. Moreover, surveillance cameras are installed by public authorities and private companies in nearly every sensitive area (public places and transportation, banks, commercial areas, etc.). All of these witness images, recorded from fixed or mobile viewpoints, contribute to generating more visual traces of critical events and all types of criminal activities [1]. Common practice in police inquiry, largely relayed by the media, recognises the crucial contribution of such images to investigations for reconstructing past events and searching for suspects, as illustrated by the investigation following the Boston Marathon bombing. The analysis of trace images of this event was very quickly conducted with the public's help after the FBI published images of the suspects[1]. The public noted many possible individuals and scenarios on the web. Because of the severity of the case and the celerity of the response required, the primary focus was on the outcome rather than the process. This example outlines that practical approaches based on the use of images exist, although they have not been deeply studied and formalised to describe how to integrate trace images from surveillance systems, witnesses or bystanders in the early stages of an investigation.

In contrast, the scientific community is increasingly concerned about the formalisation of workflows and good practices. This is part of the process of knowledge and understanding. It may even be pushed to the frontiers of the setup of standard operating procedures (SOPs) and routine protocols, which appear to be the trend in various fields of forensic science to achieve quality assurance [2,3]. Standard methods, personnel certifications and laboratory accreditation are the three pillars of quality assurance programmes [4]. Agency policies and protocols, standard operating procedures and technical manuals are being sparsely developed, notably as part of standardisation efforts, but there is still a lack of consensus on a global method. Although the guidelines precisely aim at providing a more formalised methodological frame, their effectiveness is more often than not hindered by their limited adaptability to the large scope of applications encountered by practitioners. The users of guidelines are not always involved or consulted in their conception, even though they are directly affected by their application.

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[1] http://www.fbi.gov/news/updates-on-investigation-into-multiple-explosions-in-boston.

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The forensic science literature about image analysis covers the application of techniques in depth but still lacks studies on the methodology that supports human decisions to use the appropriate tools in real-life situations [1]. In the authors' view, involving practitioners in designing a consensus from practical methodologies is of prime importance for taking into account the human dimension in the proper use of techniques. Indeed, this "proper use" is guided by rational choices and past experiences in a problem-solving framework that has not yet been formalised.

Starting from the hypothesis that sparse but highly relevant approaches have been developed and adapted by practitioners in accordance with the problems they face in their practice, we suggest formalising the foundation of consensus methodology, a bottom-up perspective. This article thus proposes to construct an innovative methodology drawn from practitioners' views and experiences in the field of image analysis in forensic science. This methodology is drawn from a research strategy based on concepts and ideas borrowed from grounded theory [5–8]. Interviews and focus group discussions were conducted to involve practitioners in the emergence, convergence and refinement of a systematic image analysis and event reconstruction methodology. Our objective was to determine how practitioners actually proceed, following the hypothesis that the most suitable methodology should emerge from a range of real-world experiences and empiricism. The results demonstrate the existence of underlying workflows among practitioners. These workflows led to the co-construction of a methodology, defined as five different steps that guide a practical approach to cases in forensic image analysis. This study provides evidence that practitioners who are involved in image analysis activities can make innovative and valuable contributions to understanding and formalising the way to use witness images for investigative and legal purposes and thus contributes to constructing the knowledge framework that encompasses their activities.

2. Research strategy

Our research strategy was inspired by the grounded theory (GT) approach, which is a qualitative approach to collecting and analysing data in a systematic, continuous and reflexive way [8–10]. GT allows for full benefit to be derived from the richness of practical experiences with real cases [11]. In contrast with laboratory experiments, it focuses on practices in natural settings and unpredictable situations, from which a bottom-up elaboration of solutions is enhanced. In this prospect, we used two distinct research tools to acquire practitioners' experiences and points of view: interviews and a focus group.

2.1. Data collection

2.1.1. Interviews

We chose to interview the main forensic image analysis practitioners in Switzerland, who were working in law enforcement agencies, police institutions or universities, with the aim of better understanding their "field" work, practices and experiences in forensic imaging. Semi-structured interviews were used for discovery and in-depth analysis. We interviewed 8 Swiss forensic practitioners, 7 men and 1 woman, with 33, 30, 27, 15, 10, 9, 8 and 6 years of experience, respectively, in image analysis and event reconstruction. We conducted our one-on-one interviews in a confidential and multi-language (French, German and English) setting between November 2012 and March 2013. We recorded each interview, the duration of which was approximately 2 h. Because of the differences in the language and jargon, an analogic transcription that centred on the content was performed for each interview. Every interview followed a common and structured protocol [12] that explored three main dimensions: (1) the context of the interviewee's work, (2) his/her professional experience and (3) the (non-)existence of a formalised work methodology and the way(s) he/she reconstructed events from images in a particular case. Regarding the third dimension in particular, we asked each interviewee to choose a case from which the workflow could be co-constructed. In doing so, progressively, each interviewee was accompanied in his/her description and formalisation of his/her workflow. Concretely, a drawing representation of each workflow was elaborated with continuous validation by the interviewee. This phase stimulated the interviewees to reflect on their approaches and their conceptualisations. At the end, the participant could review and change the diagram until he/she felt the representation was accurate. Once the workflow diagram was complete, its applicability to other cases was discussed. The way(s) other cases were processed by the practitioner allowed the solution to be put into a wider perspective of application. The workflow was redrawn or refined to depict the practitioner's work in the cases discussed.

Every evolution or new diagram that was iteratively obtained was compared with the previous ones to understand how new experiences could be integrated. The methodology was continuously readjusted interview after interview by looking for similarities and differences between them. The analysis noted recurrences, inconsistencies and particularities in the content and structure of the different workflows collected. An experienced researcher in qualitative methods independently carried out a second analysis. Both points of view were compared to obtain intersubjective results. The intermediate diagram was shaped by the participants' views and was systematically generated during the collaborative construction of the diagrams during the interviews.

A general pattern was redundantly observed among the interviews. The wording still varied, but the intermediate diagram did not evolve greatly after six interviews. It appeared that additional interviews with Swiss practitioners would not provide new insights into the methodology. That is, saturation was reached, and the sampling was adapted accordingly [13]. At this point, sampling was purposively extended to complement the findings and to further explore the processes followed by practitioners who are active in forensic image analysis but working in other countries. Thus, the time had come to hold up the intermediate diagram to the scrutiny of other practitioners in focus group discussions.

2.1.2. The focus group

We opted for focus group discussions to expose and confront the intermediate diagram that was generated from the interviews to the perspective of other practitioners from other countries in Europe. The purpose was to include points of view and experiences from different contexts (judicial systems, institutions) and cases into a refined methodology. The discussion was carried out to better assess the accuracy of the empirical interpretations and the consistency of the methodology that had emerged thus far. This subsequent phase of data collection and analysis was conducted in October 2013 with members of the Digital Imaging Working Group (DIWG) of the European Network of Forensic Science Institutes (ENFSI). The target group comprised 8 men and 1 woman who were from 9 different European countries and were experienced in image analysis (between 10 and 30 years of experience).

The main findings from the interviews, depicted in the intermediate diagram in Fig. 2, and the purpose of the discussions were first presented to initiate the focus group. This was performed in English with the practitioners who agreed to participate in our research confidentially. The procedure started with an individual reflection by each group participant, focusing on (1) the similarities and differences with his/her own workflows, (2) the changes he/she would make to translate it into his/her own practice, (3) the influence of the context and cases, and (4) any other comments