IC-CRIME Snapshots: Training Crime Scene Photographers Using Procedural Content Generation in Games

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ABSTRACT
Modern day crime scene investigation methods are continually being enhanced by the application of new technologies to improve the analysis and presentation of crime scene information, helping to solve and prosecute crimes. The IC-CRIME Snapshots system provides a games-based tool to help train forensic photographers in a virtual environment.

Author Keywords
Serious Games; Artificial Intelligence; Planning; Forensic; Evidence; Virtual Reality; Mixed Reality.

ACM Classification Keywords
H.5.1 Information Interfaces and Presentation (e.g. HCI): Multimedia Information Systems—*Artificial, augmented, and virtual realities*; K.3.1 Computer Uses in Education: Computer Assisted Instruction (CAI)

INTRODUCTION
The IC-CRIME system is a game-based tool for use by crime scene investigators to model real-world crime scenes, link objects in the virtual scene to real world databases (e.g., fingerprint, hair and fiber) and collaborate with detectives and criminologists within a 3D virtual environment. A potential new feature for IC-CRIME is the ability for crime scene photographers to make use of the system to practice skills needed to produce effective photographs while obeying rules regarding preservation of evidence [1, 7].

The IC-CRIME Snapshots project focuses on the development of a novel game-based tool to train crime scene photographers within the IC-CRIME system. Crime scene photographers often must enter unfamiliar locations where crimes have occurred, locate evidence within the location without assistance of police or lab technicians and photograph the evidence in the context of the scene. These photographs must obey particular framing and content guidelines to maximize evidentiary value [7]. The photographer must also take these photographs without disturbing additional evidence within the scene.

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Figure 1. Capturing evidence and navigating the scene

RELATED WORK
The most significant applications of multimedia technologies to the area of criminal justice have fallen into two broad categories: the development of systems for the presentation of information in the courtroom and the implementation of software tools to assist in the investigative procedures related to the processing and analysis of the crime scene. The focus of our research is on the latter; however, the IC-CRIME system has potential applications in both contexts. Consequently, in this section we describe work in both areas.

One of the key applications of 3D technology that several researchers have focused on is the presentation of evidence to jurors, investigators, forensic scientists and other parties that are involved in the legal process [5, 4, 2]. Systems that apply augmented reality to provide additional information about a crime scene have been used successfully in court cases in the United Kingdom to assist in the prosecution and conviction of criminals [2, 5]. Work by Schofield [5] on the reconstruction of criminal incidents provides evidence of the applicability of virtual crime scene reconstructions in real crime scenarios. Research in the area of augmented crime scenes by Gee, et al. [3] has focused on implementing systems to help in the collection and processing of evidence at the crime scene.

SYSTEM OVERVIEW
IC-CRIME Snapshots is a game-based training tool that uses procedurally-generated content to provide a standalone 3D virtual environment to train forensic photographers. The system generates crime scenes—interiors of houses and apartments—that contain variations which allow for a unique environment on each play through. The player can walk through the scene and photograph objects. Photographs are saved to a file and also tagged with metadata to enable their examination in-game through an inventory system. At the end

of the game session, photo metadata and scene information are exported to an XML-formatted file to enable the system to recreate the training session at a later time. Additionally, the system provides the player with an assessment of her performance in the form of detailed feedback about each photograph taken as well as about any evidence that was *contaminated* in the process of navigating the scene. Data recorded from the session enables the system or a human instructor to asses the quality of the photographs collected by the player.

USER INTERACTION

Players experience the game in the role of a forensic photographer who interacts with the scene in a first-person mode. The game simulates the experience of walking through the crime scene while observing and cataloging its contents. To this effect, we implemented basic physics and collision detection with evidence items (e.g. victims' bodies and weapons).

Players can switch between a navigation mode and a photo capture mode. The former allows them to move throughout the scene while observing its contents and the latter simulates the use of a digital camera to capture still images of elements that are visible in the scene. Additionally, players may select from different levels of difficulty to accommodate varying degrees of proficiency. An administrator mode provides more detailed information about the evidence captured to help instructors assess the performance of the player.

GAME MECHANICS

The player's main objective is to capture a photographic record of all the evidence present in the crime scene while preserving its integrity. Evidence may include elements such as victims' bodies, blood spatter, broken windows, bullet casings, and weapons. The game evaluates the quality of photographs taken by the player based on the percentage of the item that is captured in the frame without being occluded by other objects. Additionally, since players must navigate the scene to find all the evidence, the game keeps track of their movements and records any instance when they collide with or walk over evidence. Note that players do not know in advance the number of evidence items available or their location, part of their objective is to discover them.

At the end of the game session, a score is computed based on the number of evidence items that were successfully photographed and the quality of the photographs. The score is adjusted to subtract points for any items *contaminated* by the player. The game displays a letter grade (A to F scale).

PROCEDURAL CONTENT GENERATION

The game uses procedural content generation (PCG) to create a variety of training scenarios while reducing the effort of manually creating individual instances. One of the key requirements for this component was ensuring that the procedural system always generates meaningful room layouts that can be correctly rendered and successfully navigated by a player. Additionally, the resulting content needed to allow for the future integration of an AI subsystem used to develop more interesting and complex training situations. To this effect, the system produces an XML representation of the scene, its contents, and the crime scenario used during the training session.

AI COMPONENT FOR CRIME SCENE GENERATION

Currently we use a small knowledge base of crime scenarios that are randomly selected and adapted to the level created by the PCG. A future version of the game will be integrated with a planning system [8] that utilizes the scene produced by the procedural content generator and applies a detailed knowledge base of the forensics domain to create more realistic crime scenes that can achieve specific training objectives.

LOGGING AND RETRIEVAL OF PLAYER PERFORMANCE

An important component of the system is the ability to record the play-through session to allow its later recreation and analysis. Essential elements of the user interaction are stored in a set of XML files. The system is designed to use these to recreate the scene exactly as it was created by the procedural content generator. Additionally, important elements of the user interaction such as player location, the time when interactions took place, and relevant metadata are also recorded.

IMPLEMENTATION

IC-CRIME Snapshots is built on top of the Unity3D game engine [6], a tool used for many commercial video games and to teach games-specific courses to computer science students.

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REFERENCES

1. Bahamón, J. C., Cassell, B. A., Young, R. M., Thomas, J. M., Hinks, D., Litzsinger, Z. E., and Lang, E. W. IC-CRIME: A Collaborative, Web-Based, 3D System for the Investigation, Analysis, and Annotation of Crime Scenes. In *5th Int. Workshop on Computational Forensics (in conj. with ICPR 2012)* (Tsukuba, Japan, 2012), 88–99.
2. Burton, A. M., Schofield, D., and Goodwin, L. M. Gates of global perception: forensic graphics for evidence presentation. In *Proc. of MULTIMEDIA '05*, ACM (New York, NY, USA, 2005), 103–111.
3. Gee, A. P., Escamilla-Ambrosio, P. J., Webb, M., Mayol-Cuevas, W., and Calway, A. Augmented crime scenes: virtual annotation of physical environments for forensic investigation. In *Proc. of MiFor '10*, ACM (New York, NY, USA, 2010), 105–110.
4. Gibson, S., and Howard, T. Interactive reconstruction of virtual environments from photographs, with application to scene-of-crime analysis. In *Proc. of VSRT'00*, ACM (New York, NY, USA, 2000), 41–48.
5. Schofield, D. Animating and Interacting with Graphical Evidence: Bringing Courtrooms to Life with Virtual Reconstructions. In *Proc. of CGIV '07*, IEEE CS (Washington, DC, USA, 2007), 321–328.
6. Unity3D. http://www.unity3d.com.
7. Waggoner, K., Suchma, K. H., and Holliday, S. D. *Handbook of Forensic Services*. US Dept. of Justice, Federal Bureau of Investigation, Laboratory Div., 2007.
8. Weld, D. S. An introduction to least commitment planning. *AI Magazine 15*, 4 (1994), 27–61.