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Proposing Application of 3D Scanning Technology in Crime Scene Documentation

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Abstract

The purpose of an investigative sketch is to provide a correct record that shows the scene as it was found and that can be examined later. It does not require artistic ability but must be accurate enough to show the facts. The sketch is supplementary to the investigator's field notes. Hence to improvise the data being recorded, we are proposing introduction of 3D scanning to the crime scene documentation process. 3D scanning will provide us more précised and detailed results which will help the investigators to reconstruct the crime scene in a very easy and handy way. 3D scanning being digital data it will be very easy to handle and combine it with other technology like virtual Reality (VR), Simulation etc... which will increase its importance as a document as well as evidence. It's also very safe to use it digitally as we can encrypt it using hash function and its own digital profile will also help to prevent tempering.

So, in this study we are scanning 3 sample crime scenes in three different conditions by a 3D scanner and make the 3D models of the respective scenes to understand its strengths and weaknesses. So that we can use it for investigation processes and overcome its flaws.

Keywords: 3D scanning • Investigative sketching • Investigator • Document • Forensic

Introduction

What is 3D scanning?

3D scanning is a technology for creating high-precision 3D models of real-world objects. A 3D scanner takes multiple snapshots of an object. The shots are then fused into a 3D model, an exact three-dimensional copy of the object, which you can rotate and view from different angles on your computer.

What is a 3D scanned image?

A 3D scan is a three-dimensional image of part of an object's surface. Sets of 3D scans form a 3D model. Just as 2D photos are made up of pixels, 3D scans are made up of tiny triangles, or polygons. Polygons form a polygonal mesh, which replicates the object's geometry in minute detail.

What does a 3D scanner do?

A 3D scanner generates 3D scans. A scanner works like a video camera, meaning it takes shots of an object. A camera, however, makes two-dimensional stills, while the scanner captures the geometry of the object's surface, and the shots it has made are worked into a 3D model rather than a video.

Where a 3D scanner can be used?

3D scanners are used in a range of industries, from manufacturing to healthcare, at crime scenes and VR. Retrofitting heavy machinery, performing quality control of mechanical parts, designing customized prosthetic devices, creating visual effects for movies, developing characters for video games–all such projects have high-precision 3D models of physical objects at their core.

Application of 3D scanning in forensics

Advanced 3D scanning technologies are becoming increasingly popular in forensics as well, due to their portability, flexibility, and accuracy. And professional 3D scanning solutions are now being used around the world by police forces, multiple insurance companies, and even during court hearings for presenting evidence!

3D scanning in forensics is all about portability, flexibility and accuracy. For example, a portable 3D scanner with high accuracy and the ability to scan both indoors and outdoors, even in direct sunlight, makes the job of collecting forensic data easier than ever before.

Compared to the traditional methods of data capture in forensics, including photography, tape measures, etc., 3D scanning has proven itself as an extremely powerful technology with the ability to capture highly accurate data in a matter of minutes. These advanced technologies are used for a variety of forensic applications, for example, capturing the complete scene of the crime or its separate parts before the evidence is officially collected. 3D scanning is also excellent at digitizing the recovered evidence itself, creating simulations where numerous crime scenarios can be performed, analyzed, etc.

Findings and conclusions made based on the acquired 3D scanned data are so accurate and reliable that they are often presented as evidence in court [1].

What is a crime scene sketch and its significance in investigation and judiciary process?

The crime scene sketch is an invaluable aid in recording investigative data. It is a permanent record that provides supplemental information that is not easily accomplished with the exclusive use of crime scene photographs and notes. A crime scene sketch depicts the overall layout of a location and the relationship of evidentiary items to the surroundings. It can show the path a suspect or victim took and the distances involved. It can be used when questioning suspects and witnesses. During trial, the crime scene

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diagram correlates the testimony of witnesses and serves as a tool for relaying reference and orientation points to the prosecutor, judge and jury.

Hence crime scene sketching is a very important part of crime scene documentation process. And are useful in keeping the exact record of crime scene by keeping all the record of every evidence found at crime scene, with their measurement of all those evidences from particular point' establishing their position in the actual crime scene. It plays a major role in crime scene documentation as well as reconstruction. It also helps investigator to understand as well as recall the actual scene of crime. And also, to reconstruct the crime scene if needed.

Statement

"To study the Application of 3D scanning technology in crime scene sketching."

Objectives

1. To make crime scene documentation more useful and secure.
2. To digitalize the crime scene documentation.
3. To make crime scene reconstruction more detailed.
4. To establish equal standards.
5. To reduce error rate in crime scene sketching.

Definitions of the study

3D Scanning: 3D scanning is a technology for creating high-precision 3D models of real-world objects. A 3D scanner takes multiple snapshots of an object. The shots are then fused into a 3D model, an exact three-dimensional copy of the object.

Crime scene sketch: A crime scene sketch is a permanent record of the size and distance relationship of the crime scene and the physical evidence within it.

Hypothesis

As per the previous studies from some research papers and articles it has been found that 3D scanning and modeling technology has proven its utility in various fields like Medical, Prosthetics, prototyping, Museum artifact conservation etc. and can also be implemented in forensic science for various disciplines like Autopsy, Crime scene sketching and modeling, print evidence [shoe print, tool mark, indentions, etc.

Review of literature

A cost-benefit analysis of 3D scanning technology for crime scene investigation [6]. In this present research study, the researcher seeks to answer whether the up-front investment in 3D scanning technology can result in cost savings for law enforcement agencies from efficiency that the technology affords. To achieve this, the research team derived a cost-benefit analysis algorithm for 3D scanning technology and its impact on adoption by CSI units. The researcher concluded that as technological developments continue to reduce the costs associated with 3D scanning it is quite possible that this technology will become a standard part of the CSI process in the near future [2].

3D scanning and imaging for quick documentation of crime and accident scenes [1].

In this study two experiences of crime scene documentation are proposed. This study aims at exposing the main fields of application of the new technologies of 3D acquisition, and their improvement in the forensic scenario. First, a review of up-to-date techniques for 3D date acquisition are described and discussed. Also, some aspects related to data visualization and interpretation are introduced. Two case studies are then presented, which are useful to understand the advantages of 3D digital acquisition techniques applied to forensic investigations. Experiments also highlight problems and improvement needed. Finally, the researchers concluded that the integration of both techniques has been proved to add value to the achievable results. While laser scanning point clouds allow a complete reconstruction of wide and complete areas, photogrammetry focuses on small details which are however important for investigations. As demonstrated in case study 1 the availability of close-range scanners can be exploited for recording small objects after removing that from the scene. Although not exploited in the reported experiences, the proposed 3D scene documentation approach is prone to integrate other sensors, like infrared thermal cameras. These could be useful in some kinds of analyses [3].

A 3D Impression Acquisition System for Forensic Applications. Ruwan [2]. This paper presents a method with which 3D images of tire track and footprint impressions at crime scenes can be captured with high fidelity, while capturing high resolution 2D color texture images simultaneously. The resulting device is portable, easy to use, is non-destructive of the evidence, and saves time at crime scenes. The same technique can also be used in scanning the whole crime scene. The study concluded that the device has produced better quality data at a close range obtained in a larger field compared to existing devices. It avoids problems related to occlusions by using two lasers and can digitize long spans of impressions in one scan [4].

An Overview of 3D Printing in Forensic Science: The Tangible Third Dimension Rachael M. Carew. His paper describes how the potential of using 3D printing is being recognized within the various sub-disciplines of forensic science and suggests areas for future applications. For instance, the application can create a permanent record of an object or scene that can be used as demonstrative evidence, preserving the integrity of the actual object or scene. Likewise, 3D printing can help with the visualization of evidential spatial relationships within a scene and increase the understanding of complex terminology within a courtroom. However, while the application of 3D printing to forensic science is beneficial, currently there is limited research demonstrated in the literature and a lack of reporting skewing the visibility of the applications. Therefore, this article highlights the need to create good practice for 3D printing across the forensic science process, the need to develop accurate and admissible 3D printed models while exploring the techniques, accuracy and bias within the courtroom, and calls for the alignment of future research and agendas perhaps in the form of a specialist working group [5-8].

Using 3D Laser Scanners in Crime Scenes: Understanding Advantages and Disadvantages Darwin Little, Undergraduate Weber State University, 2018. The intent of this current study is to determine if scanner use is worth the cost. Primary and secondary research involving eight criteria helped discover the outcome. The findings revealed that though manual measuring and diagramming still have an important part in crime scene processing, scanners are worth the value in visual renderings, perspective observations, time management (including manpower costs), and most importantly, unmatched precise measurement and calculation capabilities.

A Sketch-based Rapid Modelling Method for Crime Scene Presentation [4]. This study integrates computer graphics, sketch-based retrieval, and virtual Reality (VR) techniques to develop a low-cost and rapid 3D crime scene presentation approach, which can be used by investigators to analyze the criminal process. First, the researcher constructed a collection of 3D models for indoor crime scenes using various popular techniques, including laser scanning, image based modeling and geometric modelling. Second, to quickly obtain an object of interest from the 3D model database, a sketch-based retrieval method was proposed. Finally, a rapid modelling system that integrates our database and retrieval algorithm was developed to quickly build a digital crime scene. For practical use, an interactive real-time virtual roaming application was developed in Unity 3D and a low-cost VR Head-Mounted Display (HMD). Practical cases have been implemented to demonstrate the feasibility and availability of our method. Finally, the researcher concluded that using their approach, police investigators can rapidly record the spatial relationships of objects while constructing a digital model of the indoor crime scene. In comparison to laser-scanning and software modelling techniques, the main advantage of the method is that it is low cost and rapid, making it very suitable for criminal investigation.

Research methodology

Three crime scenes were constructed for scanning purpose.

1. Indoor crime scene

2. Outdoor crime scene

3. Dark room crime scene

1. Indoor crime scene

In this robbery scene was created. The evidence at the crime scene includes:

- Documents
- Chair
- Table
- Dustbin
- Glass
- Diary
- Pen
- Open drawers
- Files
- Computer
- Footprints
- Stone
- Broken lock

2. Outdoor crime scene

A murder scene was created. The evidence includes:

- Dead body
- Blood pool
- Stone with blood
- Axe
- Two mobile phone
- Sandals
- Wallet
- Bracelet

3. Dark room crime scene

A kidnapping scene was created in low light or in dark room. The evidence includes:

- Dead body
- Chair
- Stool
- Plate
- Glass
- Chips
- Glass bottle
- Rope
- Cigarette buds
- Ash
- Empty chips packet
- Scarf
- Matchbox

3D scanner used for scanning the crime scenes: The scanner used was entry level portable scanner with structure io sensor and Skanect software mounted to iPad. After scanning the crime scene different images were obtained and for making 3D model its necessary to stitch different images together to make a single scanned image of crime scene. For stitching idea-maker software was used.

Results

We have scanned 3 different crime scenes with the use of portable scanner and Skanect software. The 3D images were obtained in three file formats i.e. .obj, .mtl and .jpeg. Different 3D images were stitched by using idea maker software and a single 3D image was formed. The scanned images of the crime scene after stitching are shown in Figures 1-3.

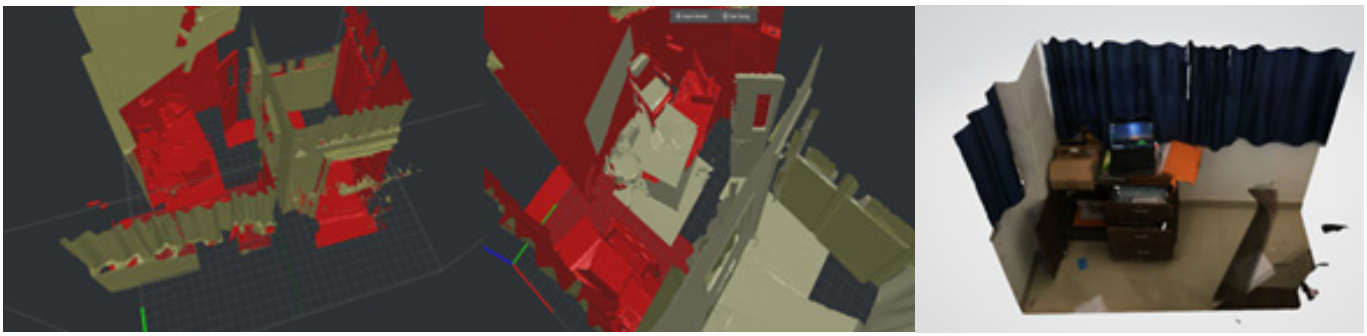

Figure 1. . Indoor crime scene 3D images. Scene with low but inough light gave very good results and was processed further. Details where very good..

Figure 2. Outdoor crime scene images damaged due to light fluctuation and couldn't be further processed.

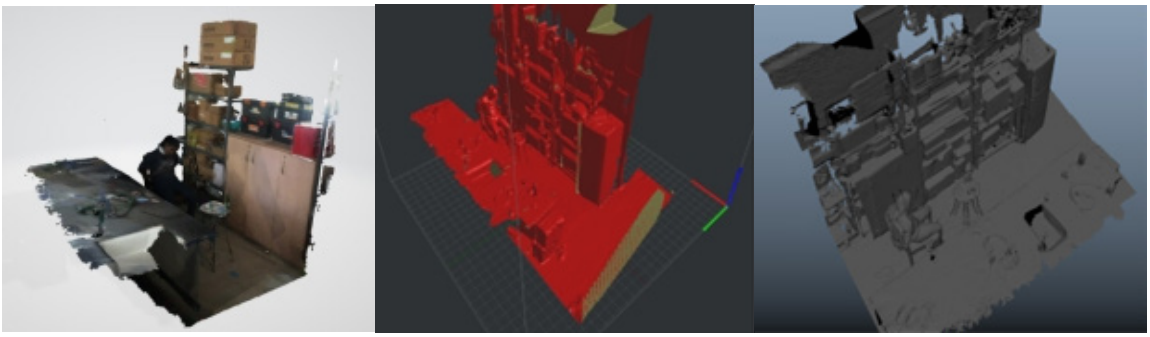

Figure 3. Dark room crime scene. Gave very good results and was processed further but still some minor flaws where observed.

Limitations

• 3D scanning is based on Infrared lights. Hence can't work in low light or dark areas.

• Needs high end support system and software makes it not easy to access.

• Restricted to a particular area i.e., bounding box.

Conclusion

Scanning the crime scenes with 3D scanner provides more accurate and precise results. In traditional crime scene sketching two methods are used rough and fine sketching. In rough sketching measurements of evidence from different points are taken and then these measurements are converted with scale in fine sketching method. But in 3D scanning there is no need to make any rough sketch or to take measurements. Measurements can be recorded with the help of 3D scanner.

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