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Multi-Device Forensic Autopsy Documentation and Report Generation Using Mixed Reality

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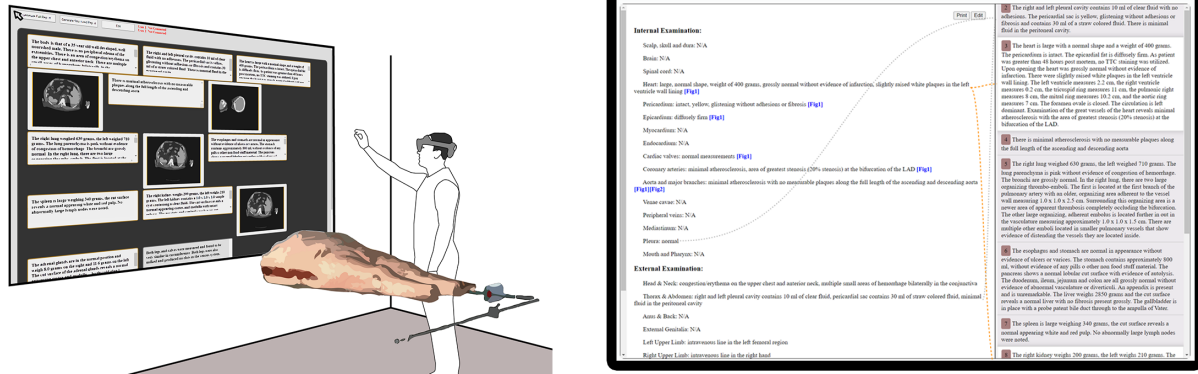


Figure 1: Autopsy report generation using MR: Left) data collection from both physical environment and mixed reality, along with organisation. Right) Compiled report with customised editor.

ABSTRACT

Forensic investigation is a complex and collaborative procedure involving multiple experts working together to finally report critical findings to legal authorities. We propose a new report generation workflow and present a novel multi-device documentation system using mixed-reality visualisation, voice and gesture interaction. Our initial findings suggest that this workflow not only enhances the thoroughness of captured data but also streamlines report generation which leads to less time and costs associated with performing autopsies. Additionally, this method offers significant potential for educational applications.

Index Terms: Human-centered computing—Human computer interaction—Interaction paradigms—Mixed / augmented reality Human-centered computing—Ubiquitous and mobile computing—Ubiquitous and mobile devices—Interactive whiteboards Applied computing—Life and medical sciences—Bioinformatics

1 INTRODUCTION

Forensic autopsies involve analysing various digital data and physical findings, and summarising analysis results in a report for the court. This is typically done at forensic institutes using low-tech methods such as employing a photographer, using dictaphones (voice recording device), taking notes on a whiteboard, and analysing CT images on PC, to prepare the aforementioned reports. However, despite their usefulness, these methods fall short in capturing all the necessary information due to time constraints, and the pathologist

must rely on their memory when preparing the report. This can be problematic because these procedures are usually carried out only once and cannot be reversed due to their invasive nature.

Immersive technologies offer the possibility to situate many critical data analysis and visualisation tasks in their true 3D context [6], in particular for volumetric data [2] such as medical and forensic activities. Focusing on forensic activities only, many studies have demonstrated how immersive technology can help integrate medical reports and post-mortem CT (PCMT) data into the autopsy operation room [1, 3], assist in examining injuries in virtual space [5], and contribute to pathology laboratories [4]. A recent study [7] proposed a more comprehensive 3D autopsy approach using mixed reality (MR) to augment physical autopsy with virtual autopsy techniques. These studies demonstrate the significant potential of MR in autopsy data analysis. Our proposed MR system for report generation and documentation could unlock further potential in forensic autopsy, a facet unexplored in literature to date.

We outline forensic autopsy report generation procedure (Sect. 2), then detail our prototype (Sect. 3), and summarise experts' feedback including use cases and limitations (Sect. 4).

2 FORENSIC AUTOPSY REPORT GENERATION PROCESS

Forensic pathologists inspect the decedent and perform a full autopsy when required by the court. They utilise CT scans pre-autopsy to pinpoint traumas and fractures, aiding the physical examination. During the autopsy, they detect traumas, fractures, take tissue samples, record organs' weight and dimensions on a whiteboard, and a photographer captures the findings' images. An assistant transcribes the recorded observations after the autopsy. They consolidate all information from the autopsy, CT scans, and lab tests into a structured report for court, referencing the images and CT slices by ID. While methods may differ among institutions, the described process outlines the general steps of a forensic autopsy.

3 GOALS AND SYSTEM DESIGN

In this project we aim to leverage MR to facilitate generation of autopsy reports by the practitioner, through a novel workflow, as

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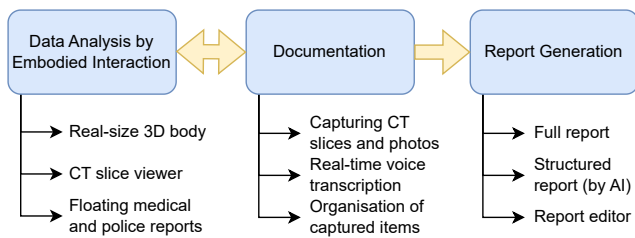


Figure 2: Our proposed workflow for semi-automated report generation using Mixed Reality.

shown in Fig. 2. Our primary goals are therefore:

1- Enabling embodied interaction. Forensic pathologists and practitioners can leverage intuitive, embodied, and free-hand interaction to facilitate their work by utilising our mixed reality system. They can seamlessly select CT slices and examine internal organs through volumetric visualisation of full-body CT images at actual size inside the autopsy operation room, eliminating the need for physical contact with input devices. Moreover, they have the convenience of accessing relevant reports, including medical and police reports, within the MR space [7].

2- Record finding and insights. In the MR environment, a pathologist can collect various data such as CT slices, photographs and transcribed voice recordings of autopsy findings – all without a need for extra devices, and are captured on the HoloLens 2. Simultaneously, the user can organise this data during or after collection using mid-air interaction with the displayed items on the 2D display (see Fig. 1.Left). The projector displays a web-based application that can also be accessed on a desktop for further and more detailed editing. During the autopsy, data collection and organisation are done iteratively, with the user going back and forth between these tasks multiple times.

Relevant information such as time, position, and orientation of captured photos and CT slices, as well as the individual responsible for each item, are recorded on-the-go. Although some of the information may not be useful in this prototype, it provides the necessary information for the complete system. By utilising the relative relationships among the recorded items, we can prepare the report with minimal need for editing.

3- Semi-automated report generation. We developed a proof-of-concept system to demonstrate the feasibility and potential of generating forensic autopsy reports using MR technology.

The system implements the following features: *real-time voice transcription*, *taking CT slices of interest*, and *taking photos of findings*.

This system generates two types of reports: a full report, and a structured report. The full report presents an easy-to-read version of the recorded items in the order in which they were organised. On the other hand, the structured report is created with the assistance of AI, such as OpenAI’s ChatGPT or Google Bard, to summarise the full report in a predefined template. To manage the CT slices and photos in the structured report, we use references in the input text that correspond to the time of capture. We instruct the AI to include these references in the summarised report, enabling us to link the summaries with the CT images and photos. We developed an editor for the structured report (See Fig. 1.Right), where the user can edit manually, merge an existing text to previous AI generated text, add text, ask for more or less detail, as well as validate the findings. By tracking the references in the summaries, the user can identify which parts have not been used by the AI and add them manually if desired.

The web app can be accessed both from within the headset in the operating room during autopsy and on a 2D display. It can also be viewed as an interactive report. The system provides a drag-and-drop

functionality to position and manipulate CT slices and photos. A user can bring these items back to MR from the interactive report.¹

4 INITIAL FEEDBACK

We conducted interviews with three experienced forensic pathologists, each with a minimum of five years of experience in performing autopsies. We presented them with video demonstrations of our prototype. In terms of use cases, they identified its utility “within the mortuary”, and for “educational purposes”. The participants particularly valued the convenience of having an all-in-one device and system. One expert found the capability to record findings during the autopsy particularly advantageous, as it reduces the reliance on memory. Another participant noted that the organised structure of the evidence and records would aid in generating the final report. In particular, one expert mentioned “including key images in a report can be helpful, especially for homicide reports”. Furthermore, they appreciated the decreased dependency on assistants, rendering the system more practical in low-resource societies.

The experts also mentioned a few drawbacks. They believe this system may decelerate the inspection procedure, while accelerating autopsy procedures. Moreover, extensive training is required.

5 CONCLUSION AND FUTURE WORK

We proposed an MR system for forensic autopsy documentation and reporting, offering advantages like less device dependency, reduced memory reliance, and less need for assistance. However, limitations include a restricted field of view, bulky headsets, and free-hand interaction issues. Future work will explore its potential for collaborative report generation and interactive educational materials.

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¹The technical features developed in this prototype are demonstrated in the video available on Youtube at <https://youtu.be/z1tMgiYQVpU>