High Resolution Surface Scanning, Radiological MSCT/MRI Scanning, and Real Data based Animations

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Abstract

In forensic medicine, the study of motor vehicle accidents occurs frequently. The situation of the impact is a crucial consideration in the examination of accident victims, such as in incidents between motor vehicles and pedestrians or cyclists. Three-dimensional technologies and methodologies are becoming more significant in forensic investigations in addition to forensic medical examinations (including autopsies and external examinations). In addition to using post-mortem multi-slice computed tomography (MSCT) and magnetic resonance imaging (MRI) to record and analyze interior results, extremely accurate 3D surface scanning is used to record external body findings and injury-causing objects. The relationship between the body's injuries and the accident mechanism and object that caused the injuries is crucial. Documenting the external and interior body, the involved vehicles, the inflicting tools, and analyzing the collected data are some of the applicable ways. By using 3D surface scanning, the body surface and the damaged accident cars were digitally captured. Post-mortem MSCT and MRI were employed for the body's interior discoveries. The analysis included converting the acquired data into 3D models, determining the vehicle's driving direction, relating injuries to vehicle damage, determining the impact situation geometrically, and assessing additional accident-related findings. The advantages of using 3D documentation and computer-assisted, drawn-to-scale 3D comparisons of the pertinent injuries with the vehicle damage in the study of accident progression, particularly with regard to the impact situation, are demonstrated in the following article using two studied examples.

Keywords: Virtopsy • Accident reconstruction • Metric wound documentation • Photogrammetry • 3D optical scanning

Introduction

The relationship between the body's injuries and the object that caused them as well as the accident mechanism is crucial for reconstructing traffic accident occurrences when a motor vehicle collides with a pedestrian or bike. The results of the forensic medical examination (external examination and autopsy) provide information about the progression of the accident events in addition to the photographic documentation and scale representation of the accident scene and the involved vehicles, as well as the investigation of traces. An essential component of the analysis is the impact situation. Three-dimensional technologies and approaches are becoming more important in forensic investigations. Along with using MRI and multi-slice computed tomography (MSCT) imaging techniques to record interior findings, extremely accurate 3D-digitalization is also used to record external findings and equipment that cause injuries [1-2]. The reconstruction primarily deals with the geometric assessment of the impact scenario and is based on comparison of the created real data based 3D models. This method's application is demonstrated in two cases:

A young child was riding his bicycle from a harvested field into a rural road when he struck with a car. Due to a severe head injury, he passed away many hours after the collision. In addition to cerebral injuries, he also sustained many haematomas, bruising, and a left tibia and fibula fracture. The implicated vehicle had damage to the right fender, the right side of the front bumper, and the bonnet, as well as other visible damage [3]. The bicycle displayed a bent mudguard, a dislocated saddle, and a left-side frame indentation. The issue of the cyclist's position in the event of a collision with the car, bicycle, and cyclist was raised.

An accident involving an automobile left a man with fatal injuries. Death happened at the scene of the accident as a result of blood aspiration combined with significant blood loss, pneumothorax, and fat embolism. The right shoulder and leg of the body had collision injuries. On the left side of the skull, there were evident injuries from the outside. Additionally, he sustained a significant chest injury. The man's condition at the time of the collision and how he was knocked over, run over, or rolled over were previously unknown. The accident reconstruction answered these inquiries [4].

A GOM TRITOP/ATOS II system was used to provide detailed three-dimensional documentation of the body surface, including the exterior injuries, as well as the involved cars and the clothing worn by the deceased at the time of the accident. This dependable technology accurately recreates an object's geometry in three dimensions and at a high resolution. Visualization is possible for even tiny structures. It can be used for the true-color 3D digitalization of both small injuries and major objects, like a car. MSCT and MRI were used to document the interior morphology and damage. a 1.5 T MRI system (Signa Echospeed) and a six-row CT scanner (Emotion 6, Siemens, Germany) at the Institute of Forensic Medicine Bern Used in the University Hospital was the Horizon, 5.8 unit, GE, USA. Before the body was scanned, multimodality (radiographic) markers (IZI Medical Products) were applied to it in order to combine surface data with radiological volume data. An all-encompassing 3D body model was created for further reconstructions. The Sliceviewer software was used to create 3D models of the deceased's osseous system and skin surface from planar MSCT images. This program uses the segmentation threshold approach to function. A sequence of 2D medical photos into 3D. Each of the object's individual pixels is marked in a binary picture and separated by a predetermined threshold value. Each image is given its own binary matrix after being divided by the threshold value. A 3D model can be computed at the slice level. The truecolor 3D models of the accident cars and the victims served as the foundation for the geometric reconstruction in three dimensions [5]. Then, using a comparison of the injuries and the car damage on a 3D model, these models were virtually moved in an anatomically precise manner to study the impact configuration. Computerized scale of one to one. The damages to the car and the injuries were geometrically combined. The size, form, and exact placements in relation to one another were continuously examined. Consequently, a proper impact position was produced. The 3D model of the victim was moved into the likely location at the time of collision in order to match the patterned injury to a specific area of the vehicle. The surface and skeleton model may be virtually manipulated in an anatomically correct way, using the real data-based knowledge of the skeleton and, consequently, the location of the victim's joints, to reconstruct the actual body position during the collision. The CT body model was imported into Disreet 3ds max to produce the reconstruction. Utilizing an adjusted skeleton model, the body model could be moved anatomically appropriately using this software. Scaling and rotation were used to adjust the joints of the skeleton model to the unique bone structure of the CT model, which was then covered by a skin model made from surface and CT data.

Discussion

In the traditional method, only 2D photos can be used to compare damages and injuries, which only allows for a rough connection of strikingly patterned injuries. Relevant insights about the progression of accident events could be recognized and visualized using computer-assisted 3D comparison of complicated datasets. Therefore, two scenarios were used to demonstrate the application of 3D documentation and computer-assisted geometric reconstruction [6]. For the matching with the accident vehicle and for the reconstruction of the contact and impact positions, the precise description of the skin findings serves as a crucial foundation. The exterior findings and the participating vehicles' highly accurate, true-color 3D surface digitization provides a strong foundation for the reconstruction and enables later deductions about the source of the results. Anytime, the digitally recorded soft tissue injuries and bone fractures from post-mortem MSCT and MRI can be merged and seen with the exterior findings [7].

In the first instance, we were able to establish that the car braked prior to the incident, which is significant information for the court and more forensic expertise. In case 2, it was possible to ascertain that the victim was kneeling when the car struck him. The two cases show how the 3D reconstruction techniques outlined above greatly enhance forensic investigations. A noncontact 3D documentation is made possible by the 3D digitalization of the body's surface and the integration with CT and MRI data from the interior body. These data can be saved and analyzed to use as a foundation for additional reconstructions. This way, even after the body has been buried, drawn-to-scale results are always available to address new inquiries. It is feasible to compare even the slightest injuries, which are indicated by color changes and deformations of the wounded body surface, with the inflicting tool thanks to the high resolution of the digital dataset of the body surface. The method of gathering the 3D-data sets has been improved. The technologies are simple to use, and the software automates the majority of the tasks. Advanced computer programming knowledge is required for data interpretation. A good degree of skill is needed for optimization and analysis with complicated actual data-based 3D models. For this method, the software had to be modified, and high-performance workstations had to be used for the analysis.

It is possible to think of the collection and computerized archiving of the drawn-to-scale, accident-relevant data as a virtual preservation of evidence. The computer can be used at any time to study the virtual objects (clothing, vehicles, etc.), and they can be added to upcoming analyses. High maintenance costs for the cars might be preserved, and the vehicles returned to the owner before [8]. Using a detailed effect study, and the 3D models of the distorted automobiles in full scale, additional physical investigations are enhanced, for instance, in the assessment of the vehicle's speed. The vast amount of data that is kept is crucial for research on accidents, such as those seen in studies on related accidents having repercussions for the automotive sector. Furthermore, a biomechanical analysis can be carried out. using these precise data and the identified contact, simulate junctures where the body and the vehicle meet. Considering the information regarding the deceased's joints, the biomechanical human. The definition of a simulation model can be more precise than until now the specialists can readily exchange the data through CD. Analyzing the situation or working in secret with other research institutes (teleforensics) (teleforensics). The presentation of the findings in illustrative graphics and legends enables a better and more impartial presentation of the outcomes. than a documented protocol is to a third party. other specialists can review the outcomes at any moment. This reconstruction technique also has the added benefit of making the events more repeatable for judges, attorneys, and laypeople in the medical field. Compared to autopsy reports, the modified data are more graphic and, since they are three-dimensional, more understandable than two-dimensional images or plans. The information can also be animated and displayed as a video clip. Furthermore, it does not matter to the viewer that the victim photographs are much less bloody than the autopsy images [9].

Conclusion

By including the corpse in the fictitious 3D accident scene, real data based 3D reconstruction makes it possible to offer accident courses information that was previously impossible. For future accident assessments, this is groundbreaking.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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