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Creating Digital Rescue Sheets

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Abstract. Rescue sheets enable rescue personnel to timely extricate trapped victims of road traffic accidents and increase their chance of survival. However, in the year 2024, these rescue sheets are still paper based DIN A4 documents. The digital transformation of the rescue process through new reporting technologies, such as eCall or the International Standard Accident Number (ISAN) facilitates digital rescue sheets, providing benefits for availability and functionality. This work addresses design considerations raised by previous research to suggest a process for the creation of digital rescue sheets. Our process transforms high-resolution models provided by car manufacturers and vendors into small files by shape abstraction of the components. The system maps the body of the car to generic representative models of defined car body types reducing the number of models that need to be stored. We develop a hierarchical tree data structure with three levels that allows appending new components of the increasingly complex cars. Our data format for transmission of the rescue sheet sends all relevant data for visualization while still retaining a small file size to account for a poor internet connection. In the future, we aim to evaluate our approach involving car manufacturers and other stakeholders.

Keywords. Accidents & Emergency Informatics, Rescue Chain, Rescue Sheet

1. Introduction

According to the World Health Organization (WHO), health is not only the absence of illness but also an individual state of complete well-being on the environmental, behavioral, physiological, psychological, social, and spiritual levels [1]. In the 1970s, Peter L. Reichertz defined an important aspect of Medical Informatics as providing the right information at the right time at the right place [2]. Combining these two paradigms, the field of medical informatics goes far beyond hospital information systems or medical image analysis.

In this paper, we focus on the early rescue chain of traffic accidents, where most health systems are not yet digital. For instance, the European eCall system, which is mandatory for new cars since 2018, establishes a voice-based phone connection between the car involved in a traffic accident and the emergency dispatcher. Likewise, the German Automotive Association (ADAC) has developed a paper-based "rescue sheet" to guide extrications from damaged cars. This standardized DIN A4 sheet contains orthographic representations of the car from the top and side views and illustrates all safety relevant components and their locations. The ADAC suggests the physical placement of a copy

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within the car [3], which makes it less helpful as it might not be accessible or even destroyed in the accident [4].

In previous work, we suggested three-dimensional (3D) digital rescue sheets that are available from the Internet and support interactive views by hiding certain components of less importance [4]. In addition, 3D rescue sheets support further information about the accident even before arriving at the site, such as predicting injury [5].

However, 3D rescue sheets are not available yet. In this paper, we design a process facilitating the digital transformation of the rescue sheet enabling the early intervention of emergency medical personnel and timely delivery of victims to hospitals through applied medical informatics.

2. Methods

Figure 1 demonstrates our pipeline to create three-dimensional (3D) digital rescue sheets. Supported by the Fédération Internationale de l'Automobile (FIA), car manufacturers have made rescue sheets available [4]. We therefore expect that manufacturers can also provide 3D models for our proposed process.

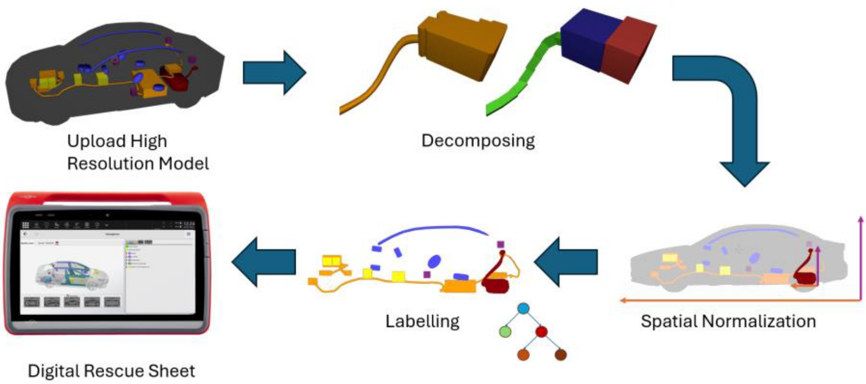

Figure 1. Pipeline creating 3D digital rescue sheets

Starting from the high-resolution model, we first reduce the complexity of the components while retaining their salient features. Through the application of shape abstraction algorithms, complex shapes can be represented by simple geometry such as cuboids, substantially reducing the file size [6].

To lower the complexity and the file sizes of the car models, we further suggest a small set of generic models that are stored locally on the client device. Since we are interested in representing the general volume and shape of the cars, we refer to existing standards such as the Society of Automotive Engineers (SAE) J1100: Motor Vehicle

Dimensions. Version 2009[2], the Australian Federal Chamber of Automotive Industries[3], ISO 3833-1977 Road vehicles – Types, or the European New Car Assessment Programme (NCAP)[4].

To map the components from a specific car model to the generic body type representation, we establish a mapping between the volumes. This step of spatial normalization takes the volume of the source car and expresses size and position as a factor of the dimensions of the volume. Given the known volume of the target generic car, we scale and position the components accordingly retaining most spatial relations between the car and its components. Figure 2 shows the benefits of the proposed system, as we can display different propulsion engines in a generic model of the same car body type while retaining the general landmarks necessary for their localization.

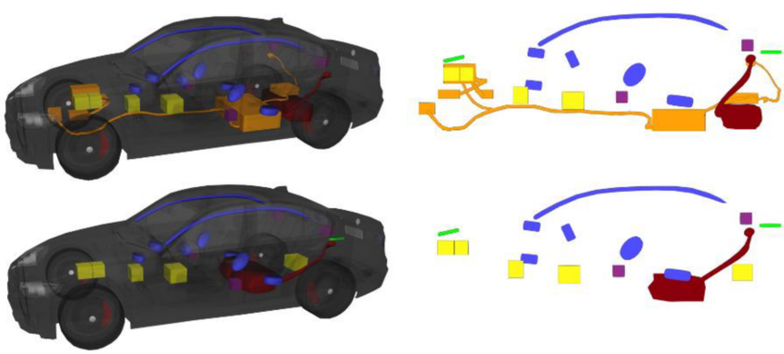

Figure 2. Visualization of safety components from a hybrid engine (electric/petrol) (top) and a petrol engine (bottom) on the car body of a 2013 BMW M3 Sedan [5]

To address the limitations of existing nomenclatures [4], we propose a hierarchical tree data structure and sort the components into categories. The first level of the tree classifies the components into two major categories. Functional components describe components that the rescue personnel can utilize, such as cutting points, lifting points, disconnects for high voltage power etc. The second category are components that pose potential risks, such as airbag, gas tank, and piston. The second level groups the components by the specific type of function or risks. The users can utilize all subsequent levels to express hierarchical relations between the components. This system implements easily and supports different views of the digital rescue sheet, as the rescue personnel can hide nodes and all their children at once. The system enforces adherence to nomenclature by allowing the user to search for leaves or traverse the hierarchical representation to find the correct labeling for the components. Administrators can add developing technologies as leaves of the graph on requests of users. All provided data is automatically stored in a database.

[2] https://www.sae.org/standards/content/j1100_200911

[3] https://www.fcai.com.au/sales/segmentation-criteria

[4] https://www.euroncap.com/en

[5] https://skfb.ly/6YDXs, “BMW M3 Sedan 2013" by David_Holiday

As we employ the system in a real-world environment, with human lives at stake, we must consider robustness and safety of the application in the event of data retrieval. To circumvent problems arising from an out-of-date database on the client-side, the system includes all necessary data into the response of a request. Figure 3 shows the process of packing the data. The identifier of the car and generic model is stored in the header of the transmission. We subsequently sent the tree of the components to correctly label all displayed parts, even if the stored tree on the client side is missing newly added entries. The body of the transmission consists of the components. Each component has a list of basic shapes that reproduce form and position and an identifier to link the component to the corresponding node in the tree data structure. Through this implementation, we assure a small file size per model, allowing for timely transmission even on old telecommunication infrastructure. To address the heterogeneity of the digital devices employed by emergency services, we envision the implementation of a 3D rescue sheet viewer, as a web application with minimal hardware requirements.

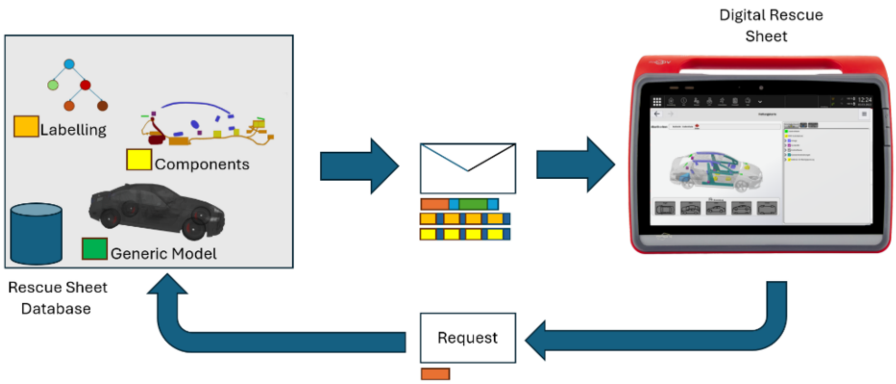

Figure 3. Transmission of the digital rescue sheet to the client

3. Results

We proposed a process to create 3D digital rescue sheets improving the rescue of victims of road traffic accidents. We answered design questions raised previously [4] by defining a set of car body types specified by published standards, which allows for the representation of various cars through generic models. Additionally, we recommended a clear 3D representation of the components by abstracting them into simple geometric objects, this leads to a small file size while accurately representing dimensions and shapes. By spatial normalization, the system accurately maps components to the generic models, while retaining spatial information. Furthermore, we defined a revised hierarchical nomenclature for the representation of the relevant components that reduces misclassification. The database administrator can extend the tree data structure with new components on the user's request avoiding proprietary naming. This also facilitates different 3D views of the digital rescue sheet. To alleviate safety concerns and provide robustness, we described a transmission file format that sends all relevant information required for visualization and minimizes client-side failures.

4. Discussion

The digital transformation of the rescue process in road traffic accidents is an important field of research fueled by emerging technologies and government enforced standards such as the eCall system or the ISAN-based rescue communication [7].
In this work, we build upon our framework for the digital rescue sheet [4]. Through our described process for the creation of the digital rescue sheet, we address several design questions. The main contributions of our work are:

- A simple but effective process to create 3D digital rescue sheets
- A new nomenclature for model components
- A new data transmission format for robust visualization

While the presented process can create functioning 3D rescue sheets, we did not address all questions raised in previous works, such as the need for a revised coloring scheme of the components, supporting transparency in 3D visualizations [4]. Furthermore, future research must evaluate the system regarding the functionality of the selected set of car body types. As in edge cases components might protrude from the generic model or relations between components and landmarks could be noticeably incorrect if a particular design differs from the corresponding generic car body type by a large margin. Our process furthers new research with the involvement of all stakeholders, paving the way for a potentially powerful tool in the process of saving lives.

5. Conclusions

While research in the digital rescue chain is still developing, we foster saving lives in road traffic accidents by improving the widely supported paper based rescue sheet in both availability and functionality. We generate 3D models with a small file size through shape abstraction from detailed car models and map them to the matching generic core model. The hierarchical nomenclature supports easy navigation through different visualizations of the models, which are calculated in real time on mobile devices.

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