

Animation-based requirements analysis of a map application user interface to support critical MCI situations

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Abstract: In *mass casualty incidents (MCI)* the emergency medical services resources are overwhelmed by the number and severity of casualties. Unpredictable catastrophic events require a lot of information about the situation and an extremely well-organized emergency management response system. To increase the chance of survival, planning and preparedness are essential. Emergency response is undergoing a technology driven transformation that calls for an intuitive and self-explanatory *user interface (UI)* visualization. We explore the current real-time map application UI for MCI to make it more user-oriented and extend the available features. The main purpose of this research is to obtain a thorough and detailed understanding of the emergency response needs and interests. Furthermore, this work concentrates on creating a detailed functional specification defining the full set of visualization modalities to be developed. Our goal is to derive concrete requirements, based on realistically conceptualized MCI scenarios, which are presented as animations. As part of the SpeedUp¹ project this paper is a foundation for further insights and research in this area.

1 Motivation and Related Work

A *mass casualty incident (MCI)* is an event, which generates more patients than locally available resources can manage simultaneously. This requires an exceptional emergency response system that provides additional information about the number, location and medical condition of patients and the emergency scene. In this paper one major goal in map application design is to display all relevant information in a more intuitive and self-explanatory way and increase the efficiency of the situational awareness. Additionally, we aim to further develop the currently existing visualization techniques and explore alternative methods and concepts. In collaboration with the Arbeiter-Samariter-Bund München²

¹The project SpeedUp is funded by the German Federal Ministry of Education and Research (BMBF) within the program „Research for Civil Security“. Website: <http://www.speedup-projekt.de>

²The Worker’s Samaritan Federation (Arbeiter-Samariter-Bund Deutschland, ASB) is an aid and welfare organization devoted to rescue services.

we identified key areas of improvement in the map visualization considering the emergency response needs and interests. The main focus was on conducting a requirements analysis that has continuously evolved through two iterations of field-studies, adapted concepts and focus-group interviews. The chain of events in the medical and resource coordination poses some serious challenges. In our research we looked for typical occurrences and problems in MCI and conceptualized them in emergency situations to create realistic animation-based scenarios. This includes issues such as communication loss, insufficient information, poor data collection, resources planning, patient monitoring and documentation.

Most of related work focus on the communication infrastructure, patient tracking and monitoring, electronic documentation, recording of patient data and GPS integration. The visualization itself, usually based on symbols, is rarely an object of interest. One of the first universal symbol languages was the *NATO Military Symbols for Land Based Systems* that has been established for years. Killeen et al. [JKL06] present the WIISARD system, which uses PDAs to store and send the patients information. However, one disadvantage of this system is the lack of real-time patients information. Gao et al. [GW06] introduce an *e-Triage* system, which includes electronic triage tags, wearable vital sign sensors, software for tracking patients and communication support. The *e-Triage* project allows the technicians to acquire patients information, electronic documentation and patient tracking. This system was further enhanced [MIS⁺12] through a new visualization approach presenting three different views. The *inter-site view* shows a map overview of the latest status in multiple first-aid stations including the number of technicians and patients of each triage category. The *intra-site view* reveals more detailed information including location, triage category and vital signs of each patient on a 3D map. Another view, the *individual view*, shows the vital signs of a single patient on a tablet PC using augmented reality techniques.

2 Concept

We developed three different MCI scenarios, which describe typical emergency situations with their most frequent challenges. Our approach was to design realistic concepts in order to visualize circumstances which reveal weaknesses in MCI and focus on the whole chain of events - from the triage to the transportation of the patients. We considered improvements of the following visualization areas in real-time: 1) communication loss, 2) patient and paramedics data, 3) various activities and events, and 4) additional information and processes. We used the open source 3D software Blender³ and satellite pictures from Google Earth for the scenarios. Previously, we designed symbols and attributes for patients (represented by colored pins in Figure 1) and vehicles in the context of the SpeedUp project. We now revisited different alternatives for the visualization techniques, which underwent more than one evaluation iteration with constructive feedback. For the representation of various situations we used traffic signs because they are self-explanatory. In addition, we rely on military symbols as recommended by the ASB.

³<http://www.blender.org/>



Fig. 1: Current UI visualization of typical critical MCI scenarios with the respective symbol for each patient, unit or object (high-resolution images are on our website⁴).

The system organization includes various visualization techniques. Fig. 1 (left) shows the collected information in detail such as location and number of patients per triage category, distinguished by color. The patient data and the allocated technicians are included in the appropriate *triage station* (depicted as a black square), which is important for the *on-scene commander*. This location overview is meant for the *ambulance incident commander (AIC)* who decides the appropriate dispatch of the medical personnel to each station. In addition, we consider possible loss of communication to some of the paramedics, which are painted in grey. Furthermore, we take into account the occurrence of street obstacles which can hinder the access to patients. We use tilted figures to avoid occlusions in the scenery. Fig. 1 (left) also adds a glow to newly detected patients with higher priority. The orange arrow on the ambulance in Fig. 1 (right) indicates the vehicle direction. Additional information about events or patients condition can be added to every object. We also considered another group visualization, which omits the patients location and ensures a clear overview of the number of patients and technicians for the AIC. For the representation of the *staging area* and of the *interim-care center* we use military symbols. In the third scenario in Fig. 1 (right) we consider a fire emergency, which is specified by its danger zone (an orange spot). Thus, we introduced new symbols for fire trucks, fire and wind direction.

In the preliminary evaluation, we presented the initial concepts and ideas to the medical personnel in order to get a first impression about their requirements. Subsequently, we were able to perform a detailed requirements analysis and to examine the user acceptance of the map application. Our final evaluation was done with five participants, who underwent individual interviews while observing the three animations without a prior introduction. During that they were asked to give feedback about the visualized data.

3 Assembled User Interface Requirements and Discussion

Through the variance of the results we were able to greatly extend the set of requirements. All of the participants agreed that the use of two different symbols for paramedics, namely

⁴<http://campar.in.tum.de/Main/TeodoraVelikova>

vehicles and persons, is too confusing and the second one is preferred. Another popular requirement is to avoid different symbol languages and to simply settle on the universal military symbols. The symbol for additional information (the orange *i*) was rated as highly useful. One very important missing feature is the possibility to manually define the shape of various stations. The visualization of objects movements is unnecessary. Moreover, the amount of displayed information should be determined by the map scale. In case of a small scale map, it should show just the number of paramedics and patients per triage category for each station. This information is required by the AIC, who needs to have an overview of the scene. On the other hand, the exact location of the patient is only important for the on-scene commander and should be displayed electively. Additionally, symbols for uninjured patients and other medical personnel should be developed. Radio call names should be displayed on every object. Furthermore, the current status of the available ambulances should be visualized. A simple map legend for military symbols could be very useful. We could visualize the transport regulations and prioritize patients according to transport emergency. Another feature that allows filtering the symbols to be displayed could be implemented. Vehicles which are not able to transport patients should be assigned a different role. Moreover, we could include a feature that allows us to displace overlapping patients to improve clarity. Finally, whenever an alert has been shown, the system should send back an acknowledgement message to all other users.

We have enhanced the whole process visualization system with some new concepts and believe that our study provides valuable insight into the future design of the map application UI. The main conclusion is that lower levels of the emergency hierarchy should be described in greater detail and include more information about the scenery. In contrast the bigger the overview, the smaller the amount of data to be visualized. This requirement makes sure that only the important information is perceived by the user. Our study is build on collaborative learning and defines some new research topics in the field of map applications. For future work we recommend to maintain a close relationship with the medical personnel in order to make more progress not just on a functional, but also on a visualization level.

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