

Real-time scalable resource tracking framework (DIORAMA) for mass casualty incidents.

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## Real-Time Scalable Resource Tracking Framework (DIORAMA) for Mass Casualty Incidents

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## Abstract

DIORAMA system which is using rapid information collection and accurate resource tracking can assist incident commanders in their attempt to bring order to the chaos as they direct rescue operations for Mass Casualty Incidents (MCI). This system makes use of active Radio Frequency Identification (RFID) tags to identify the location and status of the patients and responders involved in a MCI. The authors introduce DIORAMA's hardware and software architecture as well as the trials they conducted with up to 40 human subjects. The authors show that the DIORAMA system can significantly reduce the patient's evacuation time compared to paper triage, consequently reducing the patient's mortality. Moreover, the evacuation completeness of the DIORAMA based evacuation is always 100% as opposed to the paper-based evacuation where a number of patients are left behind. The information provided by the DIORAMA system can improve the coordination of the response to better match supply (care providers, ambulances, medical equipment) with demand (number of patients, level of acuity).

## Article Preview

## Introduction

The frequency and severity of mass-casualty incidents (MCIs) due to natural disasters or terrorist attacks resulting in large number of casualties, increased during the last decade. To handle the large number of casualties that exceed the capability of the response, first responders arriving at a mass casualty incident site must first triage patients to prioritize medical care and resource allocation. Patients are categorized into different injury levels based on MCI/disaster triage standards such as Simple Triage and Rapid Treatment (START) (Super, 1984), JumpSTART a modification of START for pediatric patients (Romig, 2002), the MASS triage model used by U.S. military (Coule, Dallas, & James, 2003), and the Secondary Assessment of Victim Endpoint (Save) focused on austere field conditions (Benson, Koenig, & Schultz, 1996). Disaster triage is different from Emergency Department triage systems, such as Manchester Triage System (MST) (Mackway-Jones, Marsden, & Windle, 2006), Australian Triage Scale (Cameron, Bradt, & Ashby, 1996), the Canadian Triage and Acuity Scale (Beveridge, Ducharme, Janes, Beaulieu, & Walter, 1999), the Emergency Severity Index (ESI) (Tanabe, Gimbel, Yarnold, Kyriacou, & Adams, 2004), etc. in that patients who have little or no chance of survival will not be resuscitated to maximize care for the majority of victims (Waeckerle, 1991).

First responders assess patients' airway, breathing, circulation, cervical collar, consciousness, and dextrose conditions, and attach paper triage tags with color coding of triage level. Triage levels are defined as follows: "red" casualties with an immediate threat to life with highest priority, "yellow" patients with significant injuries but can tolerate delayed care, "green" patients with non-urgent conditions are the third priority, while dead patients and patients with negligible chance of survival are coded "black" (Bosker, Weins, & Sequeira, 1996). Beside color coding of triage level, triage tags also record identification and additional medical information of patients. A variety of triage tags are used in disasters/MCI, such as the original METTAG Medical Emergency Triage Tags (METTAG, 2012), and currently widely adopted dynamic folding tag SMART Tag (Triage Tag, 2011) with improved ease of use, visibility and weather-proof design.

The first generation electronic triage systems (Bouman, Schouwerwou, Van der Ejck, Van Leusden, & Savelkoul, 2000; Hamilton, 2003; Chang, Hsu, Tzeng, Sang, Hou, & Kao, 2004) are designed to computerize patient identity and medical information of paper triage tags, for better record keeping and to track patients throughout the entire rescue process at different departments. For example, these tags can keep track of the patients at initial triage by a first responder, stabilization care staging area, in transit to hospital on an ambulance, and receiving definitive care at hospitals. Patients are identified by bar-code or passive RFID embedded in the paper triage tag, then their medical information are recorded with PDAs, and transmitted along with their identification wirelessly to remote servers. Medical providers at different stages can scan patients to access medical information, and help the system track patients through checkpoints.

The second generation electronic systems (Lenert, Palmer, Chan, & Rao, 2005; Gao & White, 2006; Welsh, Moulton, Fulford-Jones, & Malan, 2004; Gao, Greenspan, Welsh, Juang, & Alm, 2006; Fry & Lenert, 2006) are designed to monitor patient vital signs and track patient location in real time. Patient vital signs are monitored by medical sensors connected to intelligent triage tags that communicate to remote servers through WiFi or Bluetooth. The patients' location is determined by embedded GPS, or wireless localization using WiFi or Bluetooth signal strength.

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