Visual Analytics for Emergency Response and Training on Mobile Devices

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Introduction

During emergency response and training, situational awareness is indispensable for effective managing and safe-guarding civilians and in-field personnel. To better support both command center controllers and in-field operators, we have developed a **mobile visual analytic system** to help enhance **situational awareness** and support **rapid decision making** through integrated visual analytics.

Why mobile?

Using mobile devices for visualization provides a **ubiquitous environment** for **accessing information** and effective decision making. Moreover, mobile devices could be essential tools for emergency response if a variety of relevant information (e.g., images, videos, 3D models, and sensor data streams) can be efficaciously visualized together on these devices that have **varying capabilities and resolutions**.

Goals

A **mobile visual analytic system** for emergency response and training. The main task is to demonstrate a **low-cost monitoring** system **on small hand-held devices** such as PDA and smart phone.

Approaches

We extend our previous work for an enhanced visual analytic system for emergency response and training. Our previous work introduced a prototype visual analytic system for emergency response on mobile devices. We have improved our system by providing additional visual analytic functionalities.

The latest version of our system consists of 2D and 3D visualization components commonly required in emergency response and training situations as follows:

- **Personnel-related information**
  - ✓ current position and movement path
  - ✓ health level and activity level
  - ✓ congestion and area traveled
- **Situation-related information**,
  - ✓ distribution of temperature and toxic gases
  - ✓ changes of situational inforamtion
  - ✓ videos for personnel outfitted with camera
- **Static scene-related information**
  - ✓ 3D personnel movement
  - ✓ 3D scene and 2D map

Results

Our current system has been employed in the evaluation of two different scenarios:

- a **simulated fire evacuation** of The Station nightclub
- a testing exercise for a **rescue operation**.

Scenario 1.

The first scenario has simulated fire information including temperature, carbon monoxide, carbon dioxide and heat release rate and movement information for 419 personnel.

Scenario 2.

The second scenario includes real-time agent location, activity level, directional information and video feeds from both six on-agent and five stationary cameras.

Personnel-related information

Our system visualizes the **current position** of moving entities (2D/3D) and assets along with the **movement path** by fading lines, visualizes **congestion and area traveled**, and shows **the information of selected entities** such as

- Health level: healthy, unconscious, and dead
- Activity level: the moving speed

To help effective analysis and decision making, personnel in each status can be visualized after filtering.

Figure 1. Visualization of Personnel-related information: (Left) congestion visualization, (Middle, Right) visualization of individual information (health level, activity level), and (Middle) visualization of current position and path of personnel.

Situation-related information

Situational information provides several bases of analytic steps, and fast understanding it helps make rapid decision to get over the emergency. Our system visualizes the **changes about the surrounding environment**. The first scenario allows to visualize fire simulation data including the **temperature**, heat release rate, and **toxic gases** such as smoke, CO_2, and CO during the fire. **Video data** also provide significant situational information in emergency. In our system, the first responders can play the corresponding video stream by selecting an agent or a stationary camera.

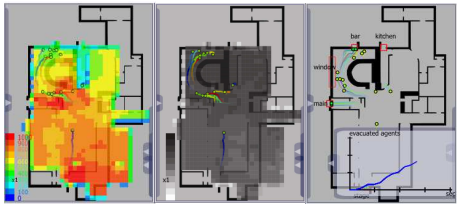

Figure2. Visualization of situation-related information: (Left) distribution of temperature, (Middle) distribution of toxic gas (CO), and (Right) graph showing the number of evacuated personnel.

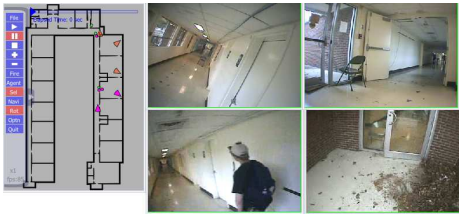

Figure3. Visualization of video streams recorded by stationary (orange circular sectors) and moving (green circles) cameras. A moving camera is outfitted on the head of an moving agent. Selected agents are showing in magent color.

Static scene-related information

The **building outlines** and **models** play a vital role in understanding and analyzing environment, and planning for emergency situation. Our system provides **both 2D and 3D views** to better understand emergency environment and factors to get over the emergency situation. Our system **annotates** and **highlights** important places such as **exit areas**. A **3D navigation** also helps train first responders by enhancing their recognition of potential evacuation routes, and visual building characteristics that may lead responders to probable alternative paths taken by people missing during an actual emergency incident.

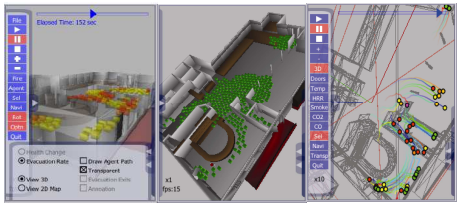

Figure 4. Visualization of static scene-related information: (Left) transparent, (Middle) solid, and (Right) wireframe view of a 3D building model.

Conclusions

We have shown a flexible prototype of our mobile visual analytics system for emergency response and demonstrated its use for a building fire evacuation and an exercise for a rescue operation. For situations requiring rapid decisions such as placement and location of public safety assets during a critical incident, our system can be used as an efficient prototype and testbed.

Figure 5. Our mobile visual analytic system running on mobile devices: (Left) Sprint PCS Vision℠ smart device PPC-6700, and (Right) OQO 02.

Literature Cited

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For further information

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