i247

Final Project Report

VAST Challenge – Building Evacuation

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Introduction

Our project aims to participate in the IEEE VAST mini-challenge competition. The IEEE Symposium on Visual Analytics Science and Technology (IEEE VAST) is the first international symposium dedicated to advances in Visual Analytics Science and Technology.

Out of the four offered mini-challenges, our group chose to address challenge 4, 'The Evacuation of a Department of Health Building.' The dataset provided by IEEE VAST is synthetic and consists of a blend of computer and hand-generated data. The dataset includes deliberate anomalies that may or may not be significant.

The VAST challenge is part of an overarching fictional scenario which is described as follows: In August 2007, a small improvised explosive device was set off at a Miami, Florida Department of Health (DOH) Building, resulting in casualties and moderate damage. A local religious group has been identified to be the suspects of the bombing. This religious group is steadfastly opposed to state-administered health care. Leaders of the religious group have publicly denied any involvement in the bombing. The DOH building was being used as a test facility for RFID (radio-frequency identification). All employees and visitors to the building wore badges enabling their location to be recorded during the time of the incident.

Goals

To investigate the VAST challenge, we created an interactive visualization to analyze the dataset. Our goals are directly aligned with the goals of the VAST competition:
1. Describe the evacuation and identify any casualties.
2. Identify potential suspects or witnesses to the event.
3. Identify any suspects who may have escaped.
4. Determine where the device was set off.

Related Work

Google's Motionfinder
We looked at Google's Motionfinder tool that is based on Hans Rosling's Gapminder. Motionfinder is a gadget within Google's spreadsheet that allows one to view motion data. Since we wanted to create an animation, we used Motionfinder initially to explore motion patterns. For example, the VAST data does not specify how much clock time one time step corresponds to. For that matter, the data does not specify whether each time step is of equal length. Thus, *a priori* we could not rule out the presence of discontinuous "jumps." Using the Motionfinder tool and mapping a subset of points, however, we concluded that in fact there were no jumps and that the time steps were uniform. We also concluded that this tool does not scale well with the

number of points, and that including all the features that we wanted in Motionfinder is not straightforward.

Games with trails

A trail is a graphic representation of the history of an entity. We believe that visualizing the trails of people in the building would help us infer who the perpetrators were. We looked at games in which entities have trails. For example, we looked at a version of chess (Thinking Machine 4) in which the pieces had trails. The trail feature has been incorporated in our tool.

Pacman

We were also interested in video games that have a floor plan and multiple moving entities. The obvious choice was Pacman because it has a building-like layout and multiple moving entities. The major takeaway from studying this game was that even with only a few moving entities that all look alike, it is hard for the human eye to focus on a particular one unless the entity is made to appear distinct from the others. We used this insight to design the "select person" feature---when a person is selected, the size of the blob increases and a "tag" with the person ID is attached to the blob. This allows the user to follow one (or some) of the selected persons (for example, the suspects).

Data

The dataset we had available for this project was supplied by the VAST challenge, and consisted of the following parts: The floor plan of the building, which was a binary data file against a 91x61 grid space. The 1's represent open spaces and the 0's indicate solid spaces (walls, closed doors, etc...). We were informed that all movement occurs within this grid space. The second file contained information about 82 individuals (employees and visitors) who were present in the building before and during the incident. For each person, this file contains time data represented by 837 units, which represent intervals between RFID tag readings. The file also contains a person ID, which identifies each person (both employees and visitors) by a unique ID and name. The last piece of data was the person coordinates taken at each time interval; these were provided in the form of x, y coordinates.

Process

Our initial analysis of the data began with loading the person RFID data into Google's Motionfinder. We wanted to investigate the basic movement of the individual people to learn if the data points were continuous or discrete. Confirming that the data was

indeed continuous was a relief as we were worried about the complexity of the problem had the data been discrete.

The next step for us was to begin developing the visualization in Flash. We first worked to load the data from the data files directly into flash. Once we had the data loaded into appropriate data structures we worked out how to loop through each person's data while at the same time looping through the time data. After the basic functionality of the visualization was working, we then began adding features such as, person names, person trails, movie controls etc…, to the tool.

With a rough working visualization of the event working with some basic features and controls, we started are usability testing. We had three different individuals for our study and based on their feedback and our observations we adjusted the visualization to suit the potential users' needs.

User Study

We conducted a usability test with three users to gather better insight and outside viewpoints of our project.

User "K" (tech savvy person)
- Wondered about the exits/building floor plan. Why isn't anything labeled?
- Used the trails feature, thought they were useful to track movements.
- Never clicked or 'rollover' feature on people until prompted to do so.
- Playback button clear from similar interfaces.
- Toggle people not sure what it does/or if it's useful.
- Was not sure what 'suspects' window is?
- Suggested to have slider for playback would be helpful.

User "M" (not a very tech savvy person)
- Wondered about the colors of people, why are they changing from blue to green to blue?
- Why are some people moving and some are not moving? Later figured out that not moving is likely casualty.
- Not easy to tell where explosion occurred without pressing 'explosion' button.
- Why doesn't explosion show up automatically? Show explosion at time of event.
- Clicked on people only after prompting.
- Would like to have a person list (and IDs) generated with on press.
- Clicking on persons too hard, they are moving around. Roll over persons should display name.
- Show casualties/survives with toggle button.

User "T" (tech savvy person)
- Would have liked to select persons and view them in bigger size.
- Would have liked if the selected persons were shown in different color.
- It is difficult to keep track of people with just a number tag in crowded places.

- Suggested if we could "Toggle people". Have just the selected people on the floor plan while the rest disappears.
- Could formulate his hypothesis on "who the perpetrator was"?

Based on the three users' comments and our observations we incorporated the following changes to our tool:

- We included a text at the top *Click on person for more detail*.
- Included *legend* for easy differentiation of what different colors meant.
- Renamed the suspect window to *Person details*. This window would include names of the person selected along with their IDs.
- Included *Slider* for easy playback.
- Included *Blast Zone* tab to show where we hypothesized the blast occurred.
- Included the feature to *increase the size* of person object for easy view.
- Included a *Filter selected* tab to show only the selected people.

Description

This is a visualization tool to aid the official investigation of this fictional event. Our intention in designing this visualization tool was that any analyst should be able to use it to solve the problems set out by VAST. The animation shows a top view of a building floor plan that is overlaid with information regarding the movement of people. The gray filled portions of the floor plan are solid spaces (walls, closed doors, etc) and the white filled portions are empty spaces. People are represented by a tiny circle, blue when they are not moving and green when they are moving. The floor plan clearly depicts the cubicle spaces and the layout of the building. Further data on the building, such as what each room or cubicle is, would help one understand more about the incident, but this data was not provided to us.

As mentioned above, every person in this event is represented by a tiny blue or green circle. The color codes of people are detailed in the top right corner by a legend. The visualization is animated over time intervals in which the RFID tag reader scans the data. The animation reproduces the movement of people in the building during the incident. Our tool also provides movie controls to control the animation of the event. The movie controls allow the user to play, pause, rewind and fast forward the animation with either buttons or a slider. The user can also reset the whole movie to start from the beginning again. These controls are provided to help the user investigate frame by frame or run through the movie many times.

Initially people are marked blue and as the animation progresses their color changes to green when someone moves. Their color returns to blue if they stop moving again. This color coding is to help the user easily identify the movement patterns, which provides clues as to who is moving during times when no one else is active.

Figure 1 ~ showing the person trails or paths of their movement

Another feature we implemented was the ability to visualize the paths that each person has traveled. (*see figure 1*) We call this feature "trails," and it enables anyone analyzing the incident with our tool to track the route that each person has taken throughout the incident. Additionally, this will allow for an analysis of the evacuation paths most often used and any potential bottlenecks. We allow for this feature to be toggled on/off and we also incorporated a toggle on/off of the person icons as well. We allowed for these two features to be used in conjunction in order to offer different views of the evacuation.

Figure 2 ~ showing the text box with selected individuals

To keep the visualization simple and uncluttered we kept the size of the individuals small and decided not to show additional features such as person's name by default. Extra details about individuals are provided on demand, i.e. when the user clicks on a particular individual the corresponding circle is magnified and a number is attached to circle. The name of the corresponding person is also displayed in a text box to the right of the visualization. (*see figure 2*) Every individual has a constant identification number, to help users remember and track individuals by their corresponding number. Clicking on the same individual icon again will remove the attached number, the name from the text box and also restore the icon to its original state.
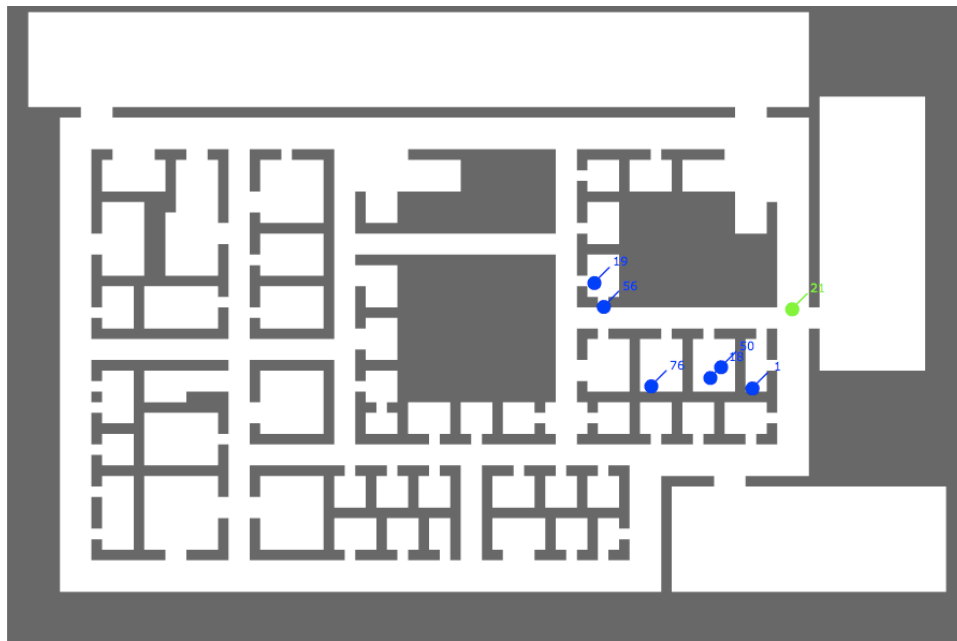

Figure 3 ~ showing the a 'filtered' view of selected individuals

The visualization also helps users to track a specific group of individuals, by retaining only a selected group of people and hiding all others. (*see figure 3*) This is done by selecting the list of individuals by clicking on them and then clicking on the 'Filter Selected' button. It helps focus on particular groups of individuals of interest and hence improves the clarity of the animation.
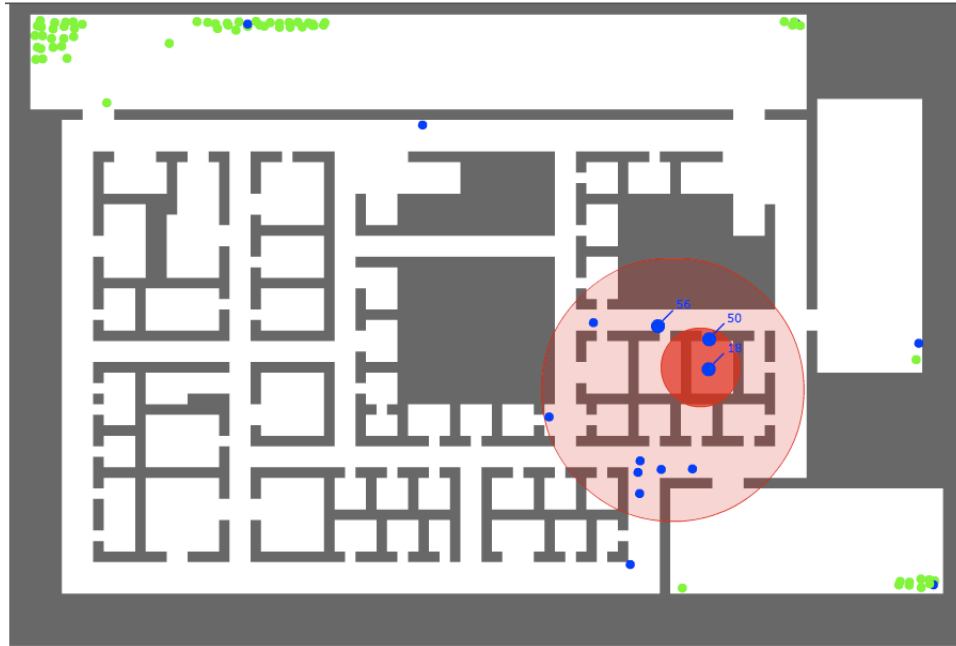
Figure 4 ~ showing the two blast zone circles

In order to identify where the device was set off we also provided a 'blast zone' option. (*see figure 4*) This would help the user to hypothesize the location of the blast and concentrate on that particular spot and observe the movement of individuals within the spot. The blast zone consists of two concentric circles; the inner (darker) circle representing the heavy casualty zone and the outer (lighter) circle representing the moderate casualty zone. These circles can be moved individually to identify the location of blast. Currently these circles are drawn manually, but we are planning to calculate the center by examining the co-ordinates of suspected casualties and defining the radius to cover most of the casualties in the region.

Results

Our visualization tool clearly shows the most common evacuation paths taken by the majority of people in the building. Potential casualties can clearly be observed when the animation ends by looking for non-moving people (blue icons) who are still inside the building. Because some of these potential casualties were moving after the explosion, it's not entirely clear if they are merely unconscious or indeed casualties.

The second goal of this project was to identify any potential suspects or witnesses. By using our tool, we are confident that the two suspects in this event are Ramon Katalanov (21) and Lindsey Bowles (1). We have come to this conclusion based on their actions prior to and after the event. The visualization shows that before the explosion, Ramon exits his office and enters one adjacent, he leaves shortly there after and appears to wait behind a large, solid portion of the building structure until after the explosion. He then proceeds to exit to a location that only 1 other individual uses. Based on his actions we are labeling Ramon as our primary suspect.

The second individual who uses this exit is who we believe to be the 2nd suspect. Lindsey Bowles (1) can be seen running towards the nearest exit rather than the exits which everyone else takes and she is out of the building within a few seconds of the explosion. On the other hand, she takes the exit which is very close to her and she is not seen meeting/talking with the other suspect, which reduces the amount of suspicion on her. Because of this, we are labeling her as a secondary suspect because the evidence against her is not as compelling. Both the primary and secondary suspect escaped unharmed to an isolated area outside the building.

Besides the people in the two offices where we believe sustained the most damage, one potential witness (if he is still alive) is Cleveland Jimenez (56). Cleveland enters a hallway and appears to be in a good position to observe Ramon (21) leaving the offices where the explosion is likely centered. The only problem with this potential witness is that he stops moving soon after the explosion, and there is no way to ascertain if he is merely unconscious or deceased. Other likely witnesses are those in the two offices were the blast was likely to have occurred. However, the probability of their survival in such close proximity to the blast is unlikely.

We hypothesized the location of explosion as shown in the *figure 4*. The reason behind our hypothesis is that the individuals in this office moved very little after the explosion and the individuals in the adjacent offices gradually stopped moving after the initial casualties.

Conclusion

The visualization we built helped us to understand the incident and accurately describe the evacuation and when the explosion occurred. We also hypothesized where the device was set off, two possible suspects, and potential casualties. Further clarification about the data, such as more detail about the floor plan (room name/type) or information regarding who are employees and who are not would give us more clues regarding the incident.

The original challenge description says that the layout is a building, but it looks like a floor plan (of a single level) and not a building layout as all the solid spaces are connected to each other. In the event of an evacuation one would assume that the occupants would leave the building premises. But it is not clear from the data if the occupants really leave the building or just exit to a lobby. It is also not clear whether everyone who is not moving is dead or some of them are simply unconscious. Clarifications on those details would help us tell a more compelling story.

The IEEE challenge problem has four other problems, which might provide more clues related to this incident. As we are dealing with only 1 of the 4 challenges, and we have not looked at any of the other data, we are unable to form a complete picture.

Work Distribution

	Initial Analysis	Create Presentations	Create Poster	MotionFinder	Usability Testing	Flash Development	Writeup
Srini	25%	10%	0%	0%	20%	33%	30%
Ethan	25%	10%	0%	0%	40%	33%	30%
Beat	25%	70%	100%	100%	0%	0%	10%
Anu	25%	10%	0%	0%	40%	33%	30%