Interactive Data Visualization on Mobile Devices for In-field Analysis

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Introduction

Mobile devices enable situational awareness and are valuable tools for in-field personnel for making timely and knowledgeable decisions. Recent advances in mobile hardware and software have increased their potential for performing advanced computations. The aim of our research is to harness these capabilities to enable in-field personnel (such as first responders and law enforcement officers) analyze data, explore it and discover insights that are not readily comprehensible from the raw data.

Challenges

Some of the important challenges in this work are:

1. Adapting visualizations to small screen spaces
2. Providing interactive graphics on computationally constrained devices
3. Providing appropriate interaction techniques

We present two case studies here, that illustrate our approaches and helped uncover both expected and unexpected knowledge about the datasets.

1. Visual analysis of Purdue Ross-Ade stadium's network data

Background

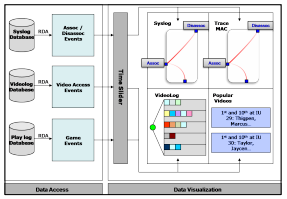
In this case study, we visualized real-time network traffic data generated from Purdue's Ross-Ade stadium during home football games. In collaboration with the eStadium team at Purdue, we distributed PDAs to random spectators, who would use these or their personal mobile devices to access the network to view game-related information such as player profiles, statistics and video highlights. This network data was logged to a remote SQL server and was visualized on a mobile device.

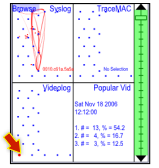
Visualization

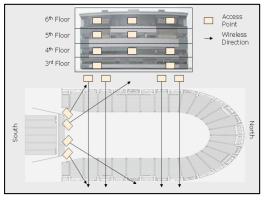
We visualized device movement across the network (based on their network connectivity), video download traffic and popular game moments based on video highlights viewed by spectators. We employed "Overview + Context" visualization technique to reduce clutter and convey only the most important information at a glance while allowing for interactive exploration to view details. A timeline allows users to look for patterns emerging over time.

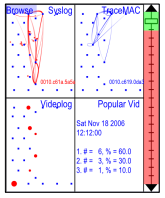
Results and Observations

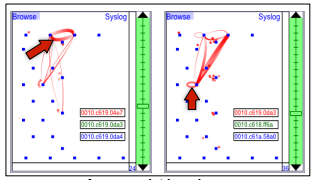
From visual analysis of data collected during Fall 2007 home games, we uncovered patterns such as access point hopping about the same point and across different points, heavily used access points and video viewing patterns of popular moments in the game. Observations such as these can be used in the field for diagnostic tasks on or off the field to improve quality of network service.

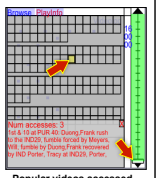

System overview


Video access denied


Access Point Locations


Overview Information


Access point hopping


Popular videos accessed later during the game

2. Visual analysis of West Lafayette crime and traffic violation data

Background

We visualized data obtained from crime reports in 2007 and 2008 and traffic violations between 2000 and 2008 in West Lafayette, IN. Both these datasets were geo-tagged and time stamped. We developed tools for spatial and temporal data exploration with linked statistics visualization to enable interactive analysis on the mobile devices.

Geospatial data exploration

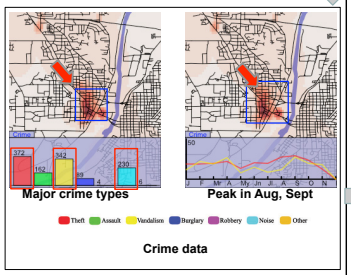
Spatial data can be explored using a focus + context based "exploration lens" that dynamically magnifies current area of interest in place and blends it into the background map. Two modes of interaction allows users to either "browse" the map or "inspect" a region in detail.

Linked statistical visualization

Data can be analyzed using visual query filters that query data based on their attributes (e.g. category), spatial or temporal location. Statistics are shown in overview level (using density estimates – the red hotspots) or in detail (histograms and line graphs). These are dynamically computed and updated as a user browses the data using the "exploration lens."

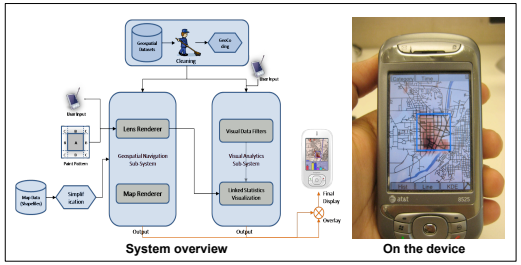
Multiple dataset visualization

Our system allows comparison of multiple datasets for examining correlations. An example of this can be seen below where public artwork installation locations are examined simultaneously with historical crime data to determine potential relation between artwork thefts and crime hotspots.



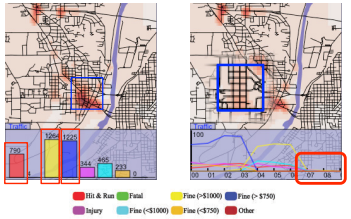
Crime data

Observations (shown in pictures)

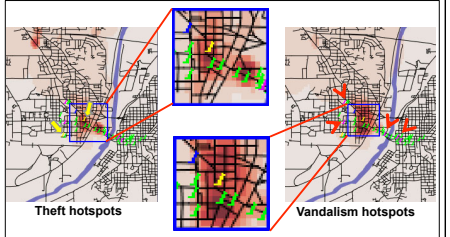


System overview

On the device



Traffic violation data


Theft hotspots
Vandalism hotspots
Crime vs. public artwork thefts

Conclusions and Future Work

1. Designed frameworks for visual analysis of different types of datasets on mobile devices
2. Need to evaluate the usability of the prototype system with domain experts
3. Implement the prototypes on newer platforms such as iPhone and Android
4. Develop advanced temporal analysis tools

Acknowledgements

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For further information

Please contact ebertd@purdue.edu for more information on this and related projects.

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