IEEE CG&A Special Issue on Visualization for Smart City Applications

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Across the globe, rapid growth and urbanization are placing increasing pressure on cities and governances to make the most efficient use of their resources. Some estimates predict that 70 percent of the world's population will live in a city or suburb by 2050. One way to address this challenge is to integrate digital technology into a city's resources, assets, and infrastructure. Community services and assets that could benefit from such innovation include local governance departments, information systems, educational institutions, libraries, transportation systems, hospitals, energy suppliers, water supply networks, waste management, and law enforcement.

A smart city attempts to use urban informatics and technology to improve or maximize the efficiency of its services and resources. Digital technology enables city officials to communicate with the community and monitor the city's infrastructure to manage local events and oversee the city's evolution, and also enables citizens to more actively participate in the decision making processes and be better informed -- all of which, hopefully, contributing to a better quality of life.

Sensors devices and monitoring systems can enable urban officials and management to collect, process, and analyze relevant data in order to tackle inefficiencies. With rapid advances in big data storage technologies and decreasing hardware costs, our ability to collect and store this data is unprecedented. Nevertheless, a large gap still remains between our ability to generate and store large collections of complex, time-dependent smart city data and our ability to derive useful information and knowledge from it.

In This Issue

We are delighted to present three articles representing the next steps forward in the evolution of visualization for smart cities.

The article, "VitalVizor: A Visual Analytics System for Studying Urban Vitality," by Zeng and Ye studies urban vitality, an indicator of lively urban experiences, an important aspect of urban design. Urban vitality is a term used to describe and reflect the quality of physical structures in an urban setting such as streets, buildings, and other infrastructure. Zeng and Ye developed a visual analytics system that combines two linked, coordinated views to explore and analyze urban vitality: a geo-spatial view and an information visualization view. The geo-spatial view preserves the location of physical properties of an urban environment while the information visualization view enables the user to analyze associated urban design metrics and correlations.

In "FaceLift: Mapping and Visualizing Urban Beautification," Kauer et al., develop a novel deep learning algorithm that can generate a more aesthetically appealing version of a given urban image such as those from Google Street view. Users can compare the original images with the beautified images and then be able to enhance a user's understanding of how the algorithm achieves this. The ultimate goal is that practitioners can then enhance and beautify real urban landscapes. The work of Kauer et al., helps users make sense of complex machine learning algorithms using information visualization.

Karer et al., study the process of a manhunt resulting from a first response crime to law enforcement in "Designing Effective Visual Interactive Systems Despite Sparse Availability of Domain Information." They study the optimization of visualization design even in the absence of a domain expert who normally drives application design. Their work leverages implicit information derived from dialogues with experienced practitioners and stakeholders. Observing the way they interact can lead to constructive insights when optimizing visualization design.

We also note that another smart-city visualization paper to appear in the Applications department of this issue. In "Spatio-Temporal Urban Data Analysis," Doraiswamy et al., elaborate on the challenges we face when designing a visual analytics system for large spatio-temporal data sets with a special focus on urban data analysis. They present a generic software architecture for smart-city data management and analysis. Case studies include New York City's (NYC) taxi traffic, tourism in San Francisco, urban shadows in NYC, and extending GIS data to include a third spatial dimension.

Smart city visualization is still in its infancy as a research direction. There are many unsolved problems and unexplored areas. With the continual introduction of sensor and other commodity hardware technology into the urban landscape, this is a very compelling application area for visualization and visual analytics. We hope that you enjoy this special issue and get a taster for this exciting topic. We look forward to future developments in the field of smart city visualization and visual analytics.

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Robert S. Laramee received a bachelor's degree in physics, cum laude, from the University of Massachusetts, Amherst (ZooMass). He received a masters degree in computer science from the University of New Hampshire, Durham. He was awarded a PhD from the Vienna University of Technology (Gruess Gott TUWien), Austria at the Institute of Computer Graphics and Algorithms in 2005. From 2001 to 2006 he was a researcher at the VRVis Research Center (www.vrvis.at) and a software engineer at AVL (www.avl.com) in the department of Advanced Simulation Technologies. Currently he is an Associate Professor at the Swansea University (Prifysgol Cymru Abertawe), Wales in the Department of Computer Science (Adran Gwyddor Cyfrifiadur). His research interests are in the areas of scientific visualization, information visualization, and visual analytics.

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Cagatay Turkay is a Senior Lecturer in Applied Data Science at the giCentre, City, University of London. His research focuses on designing visualisations, interactions and computational

methods to enable an effective combination of human and machine capabilities to facilitate data-intensive problem solving. He has a special interest in high-dimensional, temporal data stemming from bioinformatics domain, and lately from cyber security and finance. He has a background in computer science, visualization and computer graphics. He has a PhD in visualization (University of Bergen), MSc. (Sabanci Uni., Istanbul), and BSc. (METU, Ankara) in Computer Science. He has also served as a visiting research fellow at Harvard University in 2013.

Alark Joshi

Alark Joshi is an Associate Professor at the University of San Francisco. He works on data visualization projects for improved neurosurgical planning and treatment. His research focuses on developing and evaluating the ability of novel visualization techniques to communicate information for effective decision making and discovery. His work has led to novel visualization techniques in fields as diverse as computational fluid dynamics, atmospheric physics, medical imaging and cell biology. Alark received his PhD from the University of Maryland, was a Postdoctoral Associate at Yale University, and most recently a professor at Boise State University.