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EDITORIAL

Visual analysis of human dynamics: an introduction to the special issue

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For thousands of years, visual expression of human dynamics has been a part of our life. Cave paintings revealed early human social networks in hunting activities. Architectures in Roman era encoded human anatomic proportions. Those artworks reflect the social and physiological aspects of human nature, from macroscopic to microscopic levels.

Today, rapidly growing technologies such as Internet, mobile computing and sensor web have enabled new patterns of human interactions, from social networks to physiological functions. A cogent example is the rapid 'evolution' of our thumbs from holding to controlling mobile systems, just in a few recent years. Similarly, growing online communities enable spread of viruses and denial of services, similar to human physiological systems. As a result, human dynamics becomes more complex and more venerable. Unfortunately, our understanding of the natural or social human systems is very limited. Much is invisible. To make invisible visible is the goal of visual analytics. Anomalous event detection and prediction have been the key tasks for these systems. We are living in an asymmetric environment where there is an asymmetry between what are hidden and what can be seen by different entities. There are continuous threats of various cancers, both at the microscopic and social levels. Einstein once said that nature is complex, but not deceptive. Perhaps, the key difference between a natural asymmetric system and a social asymmetric system is deception.

Computational visualization of human dynamics has been rapidly growing in recent decades. At the macroscopic level, the fundamental studies of social networks such as 'the six degrees of separation'[1] and the 'power law of the linked interactions'[2] shed light on the scalability of human networking activities. Those remarkable models enrich our in-depth understanding of the dynamics in a very large network, which is a challenge to a visualization system. Spectrum graph[3] is used to visualize human activities from ambient data sources such as gas stations and cellular phone towers. Graph models such as minimal graph cuts provide abstract, yet visual tools for analyzing the outliers in a very large social network.[4] Stochastic process-based geographical profiling models have been developed to investigate serial killer's spatio-temporal patterns from the collected field data.[5] Furthermore, the cellular automata-based panic model simulates the mass dynamics in public places such as train stations. The method computationally incorporates modeling, rules and visualization in one algorithm, which enables emergent pattern discovery and rapid empirical experiments.[6] In a nutshell, the paradigm of the visual analytic social networks has been lifted from merely visual data rendering to model-based visual analysis. However, a single model may not tell the whole story. The adaptability and interaction between models and visual interfaces are perhaps potential contributors.

At the physiological level, computational visualization of human dynamics has been growing exponentially. Decades ago, human motion studies were largely dependent on the time-lapped photography, where joints were highlighted to form motion trajectories. Today, digital motion capturing and modeling systems enable the high-fidelity modeling of the motion characteristics. Functional MRI (fMRI) systems visualize human nerve and cardiac dynamics in real time. This has revolutionized the approach to physiological and psychological studies such as driving.[7] Artificial Intelligence computational models also provide augmented cognition behaviors in navigation, planning and problem solving. Driver's eye gazing model,[8] for example, was based on classic ACT-R model.[9] The model mimics human driver's visual experience like in production systems. As the developers of those systems pointed out, the sensory interactions are the weakest point in the rule-based models. The National Medical Library-sponsored Visible Human project[10] has been a milestone in establishing a foundation for the digital human. Recently, researchers have been expanding the visible human approach from anatomy to dynamics by adding physiological models, as well as multiple physics models such as bomb blast or microwave impact on the brain. Furthermore, image procession methods have been used to augment anatomic components with system dynamics and data mining.

This special issue 'Visual Analysis of Human Dynamics' came from two international workshops: SIGCHI workshop on Ambient Intelligence for Scientific Discovery (AISD-04), in Vienna, Austria, on 23 April 2004, and ICCS workshop on Digital Human Modeling (DHM-06), in Reading, UK, on 30 May 2006. AISD-04 focused on the cognitive aspects of scientific visualization, such as visual perception and interaction in data mining. DHM-06 focused on the specific digital human models ranging from gesture recognition to multi-scale human modeling. The special issue aims to provide a survey of the state of the art in the growing area with focus on visual analysis of human dynamics, including models, tools and applications in this area.

The six papers in this issue describe systematic visualization of spatio-temporal patterns from multiple large databases. In particular, pattern recognition, simulation, interaction, graph models and domain knowledge are integrated with the visualization methods. Wang and his colleagues from Pacific Northwestern National Laboratory present their vision and research projects in visual analysis of social networks with the context of counterterrorism.[11,12] Inspired by the forms in nature, Beale *et al.*[13] present the interactive visualization method for discovering similar patterns in social networks. Concerning the social responsibilities of a security technology, Laws *et al.*[14] present a privacy algorithm for hiding sensitive human features from the 3D human body scanning systems. Investigating human dynamics under extreme conditions, Imielinska *et al.*[15] present their multi-scale visual model of the brain injury trauma under a bomb blast, which combines a mesh of digitized human body, the physiological model and the physical model. Finally, Ward *et al.*[16] present a framework that combines visible humans and multi-scale physiological models within context of visible soldier project for counterterrorism.[16]

As modern computers and Internet were catalyzed by WWII and the Cold War, the new war for counterterrorism has also created new opportunities for innovative architectures that might benefit in dual-use applications. Good science starts with good questions. This special issue is not just a conventional research archive, but rather, a collection of progress reports that aim to inspire further rigorous studies.

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