

## Report on GIANT - the International Workshop on Giga-Pixel Displays & Visual Analytics (Leeds; 2/3 April 2008)

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## Introduction

GIANT - the International Workshop on Giga-Pixel Displays & Visual Analytics, took place in Leeds on the 2nd/3rd April 2008. The workshop brought together 35 people from 15 organisations in five countries, to exchange ideas and discuss how ultra-high resolution “giga-pixel” displays can best be exploited in visual analytics. The workshop was organised by the Visualization and Virtual Reality research group, in the School of Computing at the University of Leeds, and part-sponsored by the UK Visualization Support Network (VizNET).

The workshop contained two keynote presentations, a poster session, practical group work on real case studies and live demonstrations, as well as time for socialising.

## Keynote presentations

**Prof. Daniel Keim** (University of Konstanz) opened proceedings with a talk that was officially titled “Visual analytics: Challenges and Applications” but, inspired by the workshop acronym, set out to explain why *Giant Problems require Giant Solutions!*

Prof. Keim gave examples of the types of massive dataset (e.g., 150 million VISA transactions/day) that need analysing in real time today, and highlighted the fact that the critical details are often statistically insignificant, which means human-in-the-loop decision making is needed at all stages of the analysis process.

This led to six lessons from human perception that should be applied to build successful visual analytics applications:

- 1) Automatically enhance the important
- 2) Group information that belongs together
- 3) Rediscover known patterns and objects
- 4) Process data with appropriate resolution
- 5) Keep your focus moving
- 6) Keep being critical and don’t believe what you see

He concluded by reinforcing that visual analytics involves the tight integration of conventional visualization and data mining methods, and updating Shneiderman’s information seeking mantra to one better suited to visual analytics:

- Analyse first,
- Show the important,
- Zoom, filter and analyse,
- Details on demand.

**Dr Chris North** (Virginia Tech.), in a talk titled “GigaPixel displays: New opportunities for interactive visual analytics”, identified the computer as the primary bottleneck between an analyst and their task and posed four categories of research questions:

- Fundamentals
- Display design



- Visualization design
- Interaction design

Dr North then reviewed a range of research that has addressed these questions. In particular he provided evidence that physical navigation can increase task performance by a factor of 10 when compared with virtual navigation, how flat vs. curved displays each have benefits for certain types of task, and users benefit from the extra data that is shown in very large displays even if the details are beyond the limit of human visual acuity.

He concluded by summarising what (not) to do when developing applications for giga-pixel displays, and six key design principles:

- 1) Human-scale display
- 2) Persistence (leverage spatial and interaction memory)
- 3) Physical navigation
- 4) Visual aggregation
- 5) Multi-scale interaction
- 6) Collaboration

## Posters

Ten posters and overviews of the work done in attendees' laboratories were presented, covering a wide range of potential uses of giga-pixel displays, and applications in biology medicine, and the automotive and fashion industries. These were complemented by basic research into the technicalities of developing systems for these giant displays, and fundamental aspects of how users interact.



## Case studies

Attendees divided into six groups to tackle two real case studies, one from astronomy (provided by Dr Melvin Hoare and Dr Stuart Lumsden, Dept. of Physics & Astronomy, University of Leeds) and the other from transportation (provided by Dr Haibo Chen, Institute for Transport Studies, University of Leeds).



## **Young star clusters in the Galaxy**

The astronomy case study concerned data from the UK Infrared Deep Sky Surveys, and the primary challenge was what techniques could be used to aid the search for and analysis of star clusters?

One group perceived the data as occupying three different spaces: an image space with dimensions 'Declination' and 'Right Ascension'; an analysis space with dimensions J, H, K, J-H, J-K, H-K; and a physical space (x, y) occupied by our galaxy. Visual inspection of the image space may reveal regions likely to contain a cluster. Visual inspection and manual cleaning of projections of the analysis space (scatterplots of e.g. K versus J-K) could be done to search for distinctively shaped distributions of points that are characteristic of clusters. The group proposed formalising the current visual inspection of the image space to derive a probability function  $P(\text{cluster})$ , that is, the likelihood of belonging to a young cluster for each star. The user would then deselect unlikely stars ( $P < P(\text{threshold})$ ) and see the effect in the analysis space. Varying the threshold  $P$  interactively should make the characteristic star distributions in the scatterplots more distinctive as unlikely stars are removed, but allow flexibility as to how much of the distribution to exclude. If depth information could also be inferred in addition to the recorded dimensions of the image space, then the same visualization could be carried out in the physical space, in order to search for clusters in situ within the spiral arms of the galaxy.

Another group divided up their approach into two phases. The first was exploratory that involved applying a variety of existing visualization methods, complemented by global and local classification/learning techniques. The second centred on finding projections for the data that were more informative, and then applying dense pixel visualization methods.



## **Reducing air pollution with an Intelligent Transport System**

The transportation case study involved merging traffic flow data with vehicle emissions data, so that air pollution could be reduced by innovations in Intelligent Transport Systems. Among the approaches suggested by the groups was one that involved treating the problem as a flow problem, applying ideas from the visualization of computational fluid dynamics and linking the solution to Daniel Keim's six lessons. Traffic flow would be modelled as a stream of particles, whose density would correspond to the density of traffic, and whose speed at any point would correspond to the velocity of traffic. It did not seem necessary to map one-to-one vehicles to particles, but imagined using particles as an abstraction. The mapping onto Keim's six lessons was as follows:

- 1) *Automatically enhance the important*: The length of time a vehicle is stationary is crucial. To enhance this, the particles would be grown during any

period when they were stationary, bringing them to the user's attention. When the traffic moved, the particles would rapidly return to normal size.

- 2) *Group information that belongs together*: This is a natural consequence of the proposal. Particles will group together spatially.
- 3) *Rediscover known patterns and objects*: It is anticipated that the visualization will naturally indicate the behaviour of traffic at junctions. That is, it will be possible to track traffic turning left/right just from the density information at junctions.
- 4) *Process data with appropriate resolution*: A widget will allow temporal control. This will allow the visualization to run at fine resolution in the rush-hour and larger grain resolution during the night. The use of glyphs at junctions would aggregate data.
- 5) *Keep your focus moving*: Visualizations would be displayed on a Powerwall. The large screen estate would allow the traffic engineer to examine different parts of the network by walking around.
- 6) *Keep being critical and don't believe what you see*: Uncertainty information would be found from the modeller, and used in the display.



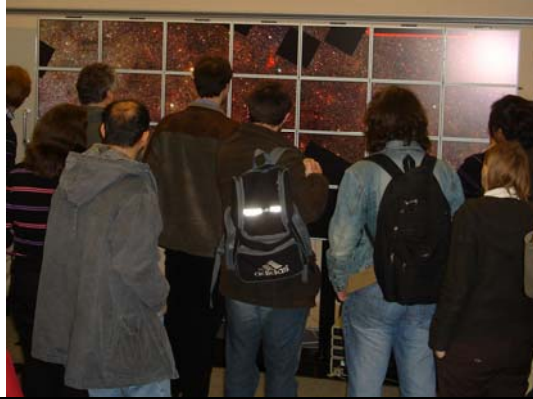
## Socialising



## Demonstrations

All GIANT's attendees had the opportunity to try three live demonstrations for themselves, on Leeds' 53-million pixel display. Each demonstration showcased a different aspect of the research taking place at Leeds.

Chris Goodyer, Ken Brodlie, Jason Wood and John Hodrien used isosurfacing techniques to construct a 3D model of cardiac anatomy from 1440 two-dimensional MRI scans, provided by researchers at the University of Oxford. Goodyer et al's work subsequently won the 2008 VizNET Visualization Showcase competition.



The image viewer developed by John Hodrien, Jason Wood and Roy Ruddle places no limit on the size of image that can be viewed, panned, zoomed and generally interacted with in real time. It was demonstrated using a 7 billion pixel picture from the UKIDSS Galactic Plane Survey, which was provided courtesy of Melvin Hoare (Dept. of Physics & Astronomy, University of Leeds) and Nigel Hambly (Royal Observatory, Edinburgh).

Chris Rooney demonstrated a novel prototype window manager, which he has developed with Haibo Chen and Roy Ruddle. Rooney et al.'s approach is designed to dramatically speed up everyday interaction tasks performed when rich, multi-window functionality is implemented in giga-pixel display applications.

