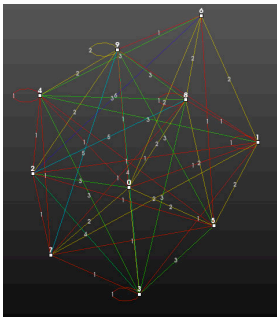
Interaction & Picking



Mary DeVarney

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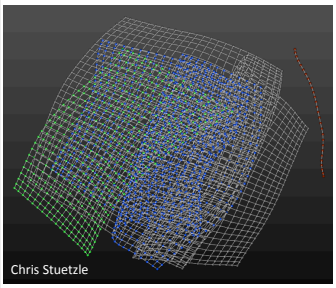
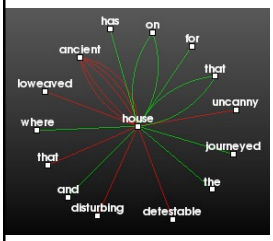
Real 3D Coordinates



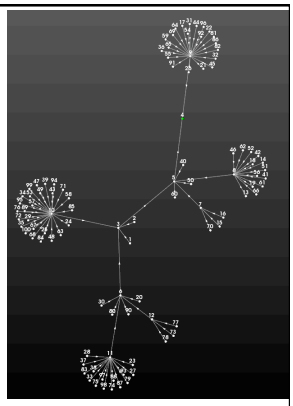
Chris Stuetzle

Evan Sullivan

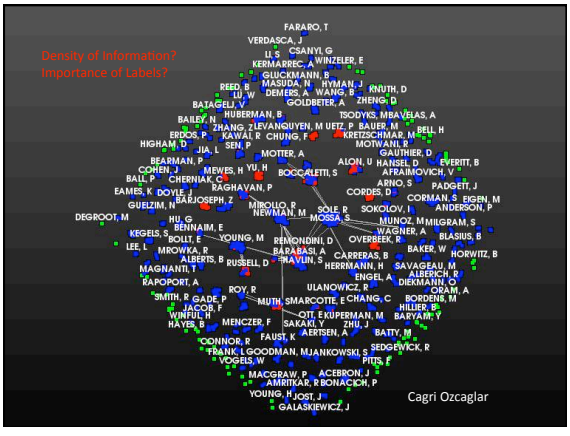
Simplicity



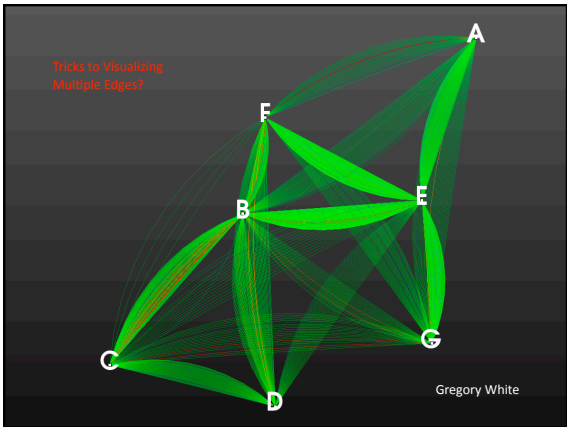
William Fergus



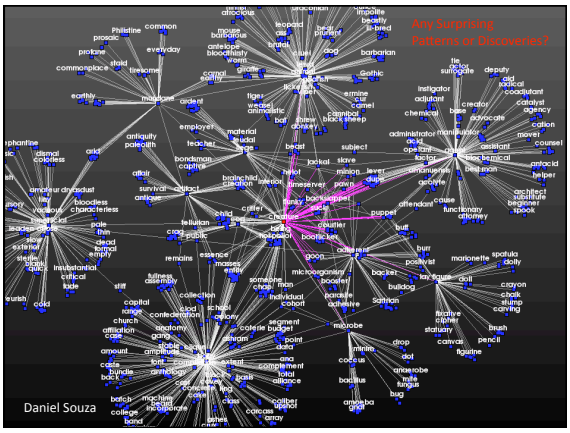
Andrew Dolce

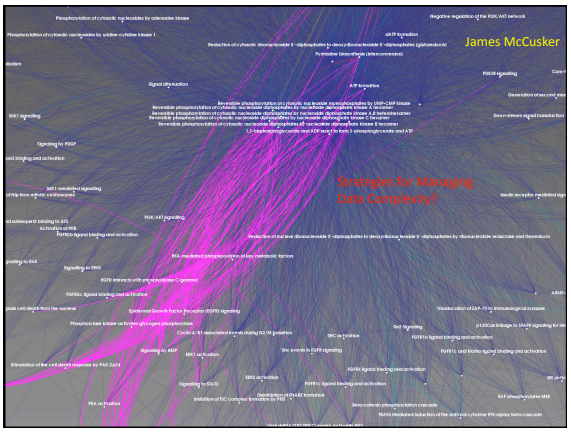


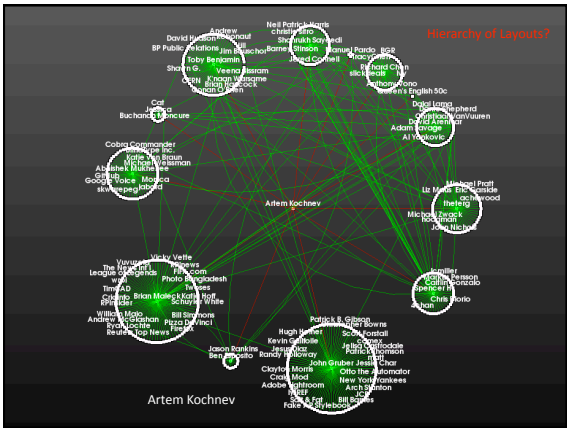
Cagri Ozcaglar



Gregory White







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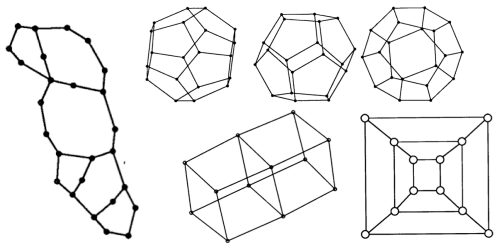
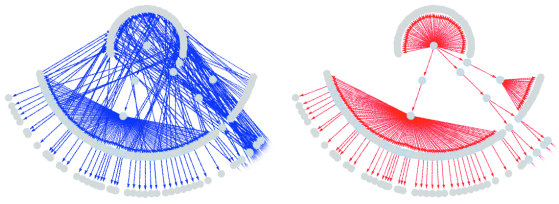
Readings for This Week:

- "Graph drawing by force-directed placement", Fruchterman & Reingold, 1991



Readings for This Week:

- "Heapviz: Interactive Heap Visualization for Program Understanding and Debugging" Aftandilian, Kelley, Gramazio, Ricci, Su, & Guyer, 2010



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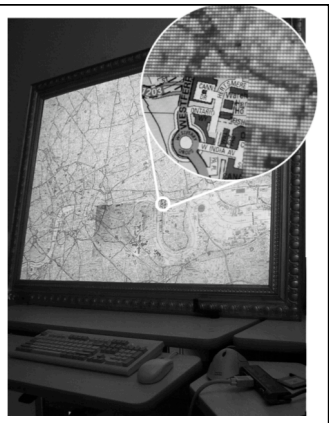
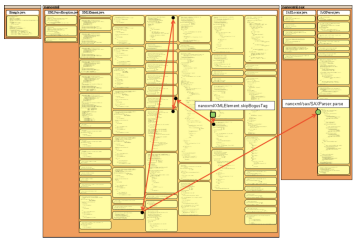
Readings for Next Week:

- "Focus Plus Context Screens: Combining Display Technology with Visualization Techniques", Baudisch, Good, & Stewart, UIST 2001



Readings for Next Week:

- "Visualization of Exception Handling Constructs to Support Program Understanding", Shah, Gorg, & Harrod, Software Visualization 2008



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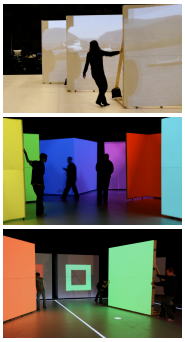
Dynamic Projection Surfaces for Immersive Visualization

Theodore C. Yapo, Yu Sheng, Joshua Nasman, Andrew Dolce, Eric Li, and Barbara Cutler

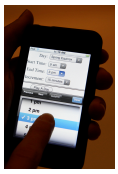
PROCAMS 2010 IEEE International Workshop on Projector-Camera Systems, June 2010

Our System Goals/Requirements

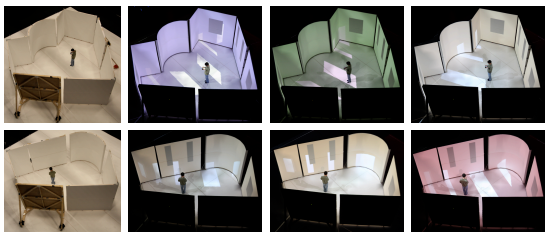
- Large, human-scale projection environment
- People move freely within the space
- Projection surfaces can be moved interactively
- Varying illumination conditions
- Robust & real-time tracking and display



Architectural Daylighting Design

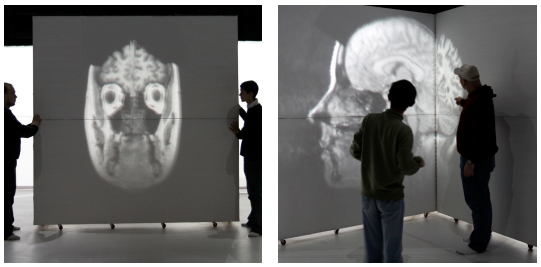


- Windows, wall colors, & time of day controlled through iTouch interface



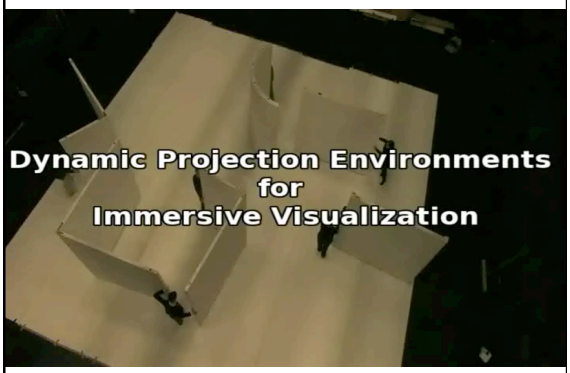
Volumetric Visualization

- Cross sections of a 3D medical dataset virtually placed within the projection volume



General User Interface Elements

- Projection surfaces as input devices
- No instruction necessary to play the game!



Panorama from Gehua Yang, DualAlign

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Introduction to VTK: Interaction

What is Interaction?

- Manipulating the objects in a scene
  - Moving
  - Rotating
  - Selecting
  - Deleting
- Manipulating your view of the scene (manipulating the camera)
  - Pan
  - Tilt
  - Zoom

Interaction Devices

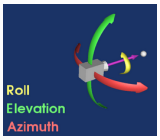
- Keyboard
  - Press a key
  - Hold a key

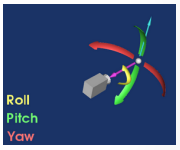
- Mouse
  - Left button
  - Middle button
  - Right button
  - Single click
  - Double click

- Joystick

- 3D mouse (3D Connexions Space Navigator)

Manipulating the Camera





Interaction in VTK

- Callback functions
  - Less overhead
  - Less powerful
- Subclass an existing vtkInteractorStyle
  - Preferred method

Callback Functions

void ClickCallbackFunction (vtkObject* caller,
long unsigned int eventId,
void* clientData,
void* callData)

caller – The object that called the callback.

eventId – What happened to trigger this function?

clientData – Give the callback access to an object.

callData – Additional information specific to this particular call.

Callback Functions (cont.)

```
void RefreshCallback( vtkObject* caller, long unsigned int eventId, void* clientData,
void* callData)
{
  // Get the object that called the callback
  vtkRenderWindowInteractor *iren =
    static_cast<vtkRenderWindowInteractor*>(caller);

 // Access anything you put in clientData
  vtkActor* actor = static_cast<vtkActor*>(clientData);
}
```

Connecting the Callback

```
vtkCallbackCommand* refreshCallback =
  vtkCallbackCommand::New();

refreshCallback->SetCallback(RefreshCallback); // The name of the function you have
defined above

refreshCallback->SetClientData(actor);

renderWindow->AddObserver(vtkCommand::ModifiedEvent,refreshCallback);
```

Observable Events in VTK

- LeftButtonPressEvent
- LeftButtonReleaseEvent
- MiddleButtonPressEvent
- MiddleButtonReleaseEvent,
- RightButtonPressEvent
- RightButtonReleaseEvent
- KeyPressEvent
- KeyReleaseEvent
- MouseMoveEvent
- Many more (see EventIds enum here http://www.vtk.org/doc/nightly/html/classvtkCommand.html)

Callback Functions Examples

- http://www.vtk.org/Wiki/VTK/Examples/Cxx/Interaction/KeypressObserver
- http://www.vtk.org/Wiki/VTK/Examples/Cxx/Interaction/MouseEventsObserver

vtkInteractorStyle

- Abstract class to catch user actions
- Subclasses implement particular functionalities
- Subclasses included in VTK:
  - vtkInteractorStyleTrackballActor
  - vtkInteractorStyleTrackballCamera
  - vtkInteractorStyleRubberBand2D
  - Many more (see http://www.vtk.org/doc/nightly/html/classes.html)

Existing InteractorStyle Examples

- vtkInteractorStyleTrackballActor
  http://www.vtk.org/Wiki/VTK/Examples/Cxx/Visualization/MoveActor
- vtkInteractorStyleTrackballCamera
  http://www.vtk.org/Wiki/VTK/Examples/Cxx/Visualization/MoveCamera

Custom Interaction -Subclassing InteractorStyles

- The idea is to simply re-implement functions like OnKeyPress, OnLeftButtonDown, etc with your own functionality
- There is some overhead because of VTK's structure

Custom Interaction -Subclassing InteractorStyles (cont.)

```
class CustomStyle : public vtkInteractorStyleTrackballCamera
{
public:
  static CustomStyle* New();
  vtkTypeMacro(CustomStyle, vtkInteractorStyleTrackballCamera);
  virtual void OnLeftButtonDown()
  {
    std::cout << "Pressed left mouse button." << std::endl;
    // Forward events
    vtkInteractorStyleTrackballCamera::OnLeftButtonDown();
  }
};

vtkStandardNewMacro(CustomStyle);
```

Using Your New Interactor

- Just like before!

```
vtkRenderWindowInteractor* renderWindowInteractor =
  vtkRenderWindowInteractor::New();

renderWindowInteractor->SetRenderWindow(renderWindow);

CustomStyle* style = CustomStyle::New();

renderWindowInteractor->SetInteractorStyle(style);
```

Custom InteractorStyle Examples

- Keypress events
  http://www.vtk.org/Wiki/VTK/Examples/Cxx/Interaction/KeypressEvents
- Mouse events
  http://www.vtk.org/Wiki/VTK/Examples/Cxx/Interaction/MouseEvents

Picking

- Get the world coordinates of a mouse click
- vtkPropPicker

Picking (cont.)

```
virtual void OnLeftButtonDown()
{
  // Get the screen/window/pixel coordinates
  int* clickPos = this->GetInteractor()->GetEventPosition();

  // Pick from this location
  vtkSmartPointer<vtkPropPicker> picker =
    vtkSmartPointer<vtkPropPicker>::New();
  picker->Pick(clickPos[0], clickPos[1], 0, this->GetDefaultRenderer());

  // Get the world coordinates
  double* pos = picker->GetPickPosition();
  std::cout << "Pick position (world coordinates) is: "
            << pos[0] << " " << pos[1] << " " << pos[2] << std::endl;
```

Picking Example

- http://www.vtk.org/Wiki/VTK/Examples/Cxx/Interaction/Picking

Object Intersection

- VTK does not have much to offer
- There is a nice "add on" (http://www.midasjournal.org/browse/publication/726) that wraps GTS (GNU Triangulated Surface Library)
- What you can do is "Point inside object" testing

Point Inside Object

```
vtkSelectEnclosedPoints* selectEnclosedPoints =
  vtkSelectEnclosedPoints*::New();

selectEnclosedPoints->SetInput(transformPolyData->GetOutput());

selectEnclosedPoints->SetSurface(this->Sphere);

selectEnclosedPoints->Update();

vtkDataArray* insideArray =
  vtkDataArray::SafeDownCast(
  selectEnclosedPoints->GetOutput()->GetPointData()->GetArray("SelectedPoints"));
```

Point Inside Object (cont.)

```
bool inside = false;

for(vtkIdType i = 0; i < insideArray->GetNumberOfTuples(); i++)
{
  if(insideArray->GetComponent(i,0) == 1)
  {
    inside = true; break;
  }
}
```

Positioning an Actor (round 2)

- In a previous class we learned about vtkActor::SetUserTransform
- However, when you interact with an actor, other internal stat variables (Position and Orientation) are modified.
- The UserTransform is generated from the Position and Orientation, so if you REALLY want to set the position/ orientation, use:

```
this->CubeActor->SetPosition(0,0,0);
this->CubeActor->SetOrientation(0,0,0);
```

Intersection Example

- http://www.vtk.org/Wiki/VTK/Examples/Cxx/Interaction/Game