The Smart Surgical Image

W. Brent Seales, PhD
Vis Center
University of Kentucky
The Smart Image

• Composite: Image that makes specific, important information explicit
  – Metadata (annotation)
  – Spatial location (maps)
  – Temporal information (history)
  – Fusion (multi-sensor data)
The Smart Image

• Rendered: Involves algorithmic calculation, such as registration or geometric manipulation
The Smart Image

- Interactive: Manipulations specified on the image can be translated into information or actions
The Smart Image: Need

- MIS removes the surgeon from the operative field creating a challenging, remote environment
- Cameras restrict pose and field of view
- Disparate data is rarely presented in a common frame of reference
The Smart Image: Complexity

• New requirements and methods increase environment complexity
• “Focus of attention”
  – Delivery of information at the right time
  – Reduction of superfluous information
• Cognitive functions
  – Planning
  – Situation awareness
  – Mental workload
The Smart Image: Components

- Computational framework
- Sensors
- Algorithms for data visualization
- User interface
- Display framework
- Cognitive ergonomics
Smart Image Focus Area

The computing architecture should support on-demand construction and display of complex imagery.

- Registration – merging sensor data
- Database access – annotation, etc.
- Multi-Modal – volumetric, 3D, spectral
- Display – larger display real-estate
Computing Architecture
Mental workload and other cognitive measures are crucial indicators of how “smart” a smart image really is.

- Misplaced information focus can be a distraction.
- Misleading data can create inaccurate mental models.
Global coordinate frame for multiple sensors over time is difficult to establish

Pre-operative data do not easily align with intra-operative information

Non-rigid deformation creates challenges
The visualization and control of imagery in time and space is crucial to its usefulness.

- Spatial options: 2D, 3D, spectral registered, “perspective enhanced”
- Temporal options: video, history, multiple data sets (pre- and intra-operative)
Temporal Composition

- Panoramic composites
- History of movement
- Temporally-constructed texturing
UV, Royal Blue,
Blue, Cyan,
Green, Amber,
Red-Orange, Red,
IR, IR, IR, IR, IR,
and a composite RGB
Acknowledgements

- Ruigang Yang, PhD
- Melody Carswell, PhD
- Qiong Han, PhD
- Xiangming Wang, Doctoral Student
- Cindy Lio, Doctoral Student
- TATRC/US Army
- The Maryland ORF Team