Perception & Information Visualization

Matthew Brehmer

CS533C Topic Presentation

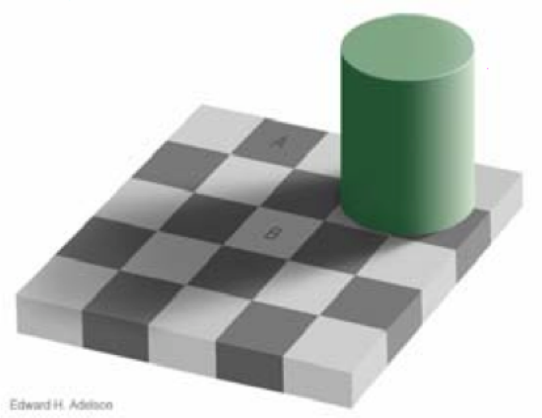
November 25, 2009

- Face Perception & Colour
  - Kindlmann, G. , Reinhard, E. , & Creem, S. (2002). Face-based Luminance Matching for Perceptual Colormap Generation. *Proc. Vis 2002* .
- Motion
  - Huber, D. E. , & Healey, C. G. (2005). Visualizing Data with Motion. *Proc. IEEE Visualization 2005* , pp. 527-534.
- Haptic Perception
  - Yannier, N. , Basdogan, C. , Tasiran, S. , & Sen, O. L. (2008). Using Haptics to Convey Cause and Effect Relations in Climate Visualization. *IEEE Transactions on Haptics 1 (2)* , pp. 130-141.

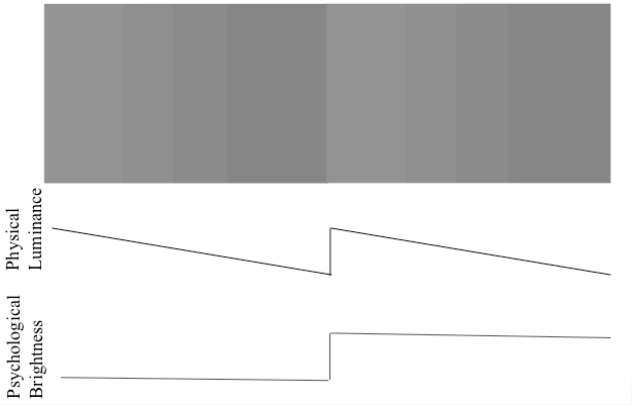
Face-based Luminance Matching for Perceptual Colormap Generation

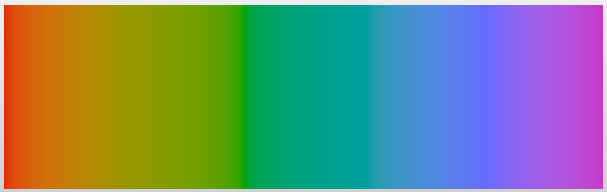
Kindlmann, G. , Reinhard, E. , & Creem, S. (2002). *Proc. Vis 2002* .

Adelson 'illusion'

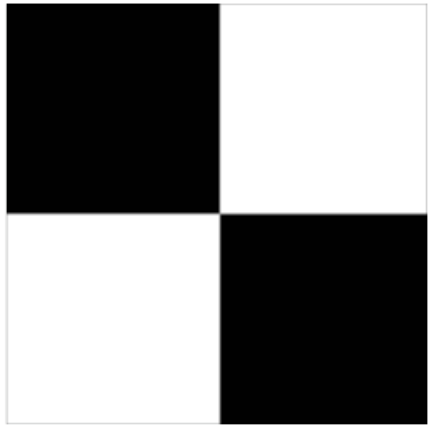


Craik-O'Brien-Cornsweet Illusion



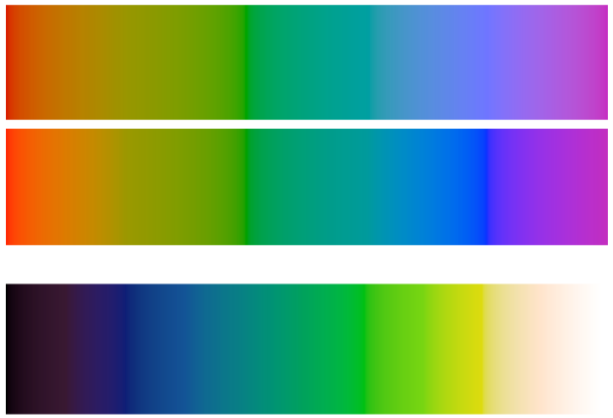


- Problem
  - creating isoluminant colormaps
  - unknown display / room conditions
- Luminance
  - intensity of light / unit area reaching eye
  - photometric quantity
  - display of image structure, surface shape
- Solution
  - novel luminance matching technique
  - use of ability to detect faces



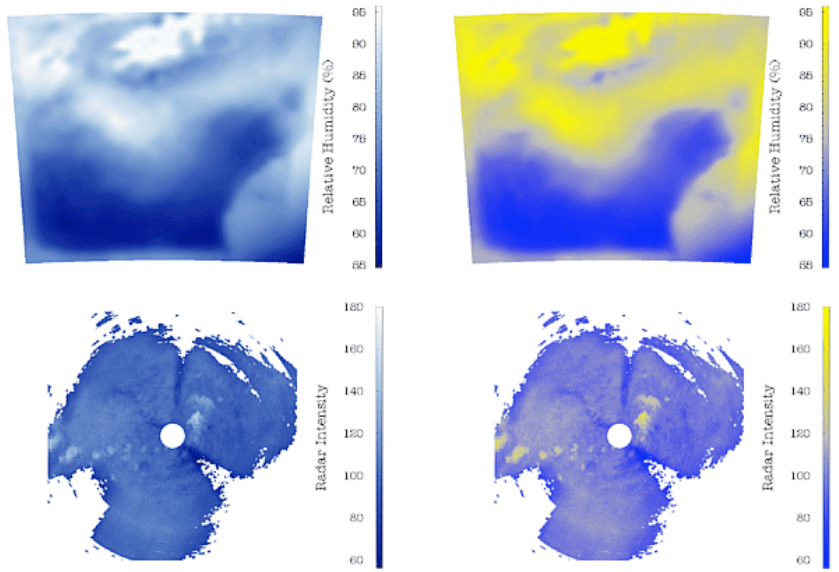
- Background
  - luminance measuring techniques based on matching paradigm
  - for InfoVis, a predetermined pattern of luminance variation is often desired
- Current Practice / Previous Work
  - minimally distinct border (MDB)
  - challenging with different chromaticities
  - threshold face images

- Method
  - replace threshold image colours: black with a shade of grey, white with a colour
  - one face appears positive
- User Study
  - compare technique with adapted MDB
    - preserve border length
  - task
    - adjust HLS lightness
    - find cross-over point



- Results
  - same accuracy and RT as MDB
  - better precision than MDB
- Colour map generation
  - user study: 1st step in creating isoluminant colormap
  - avg. control pts. across participants
  - interpolate colormap values in RGB space (with γ estimate)
  - can also generate colormaps with monotonically increasing luminance

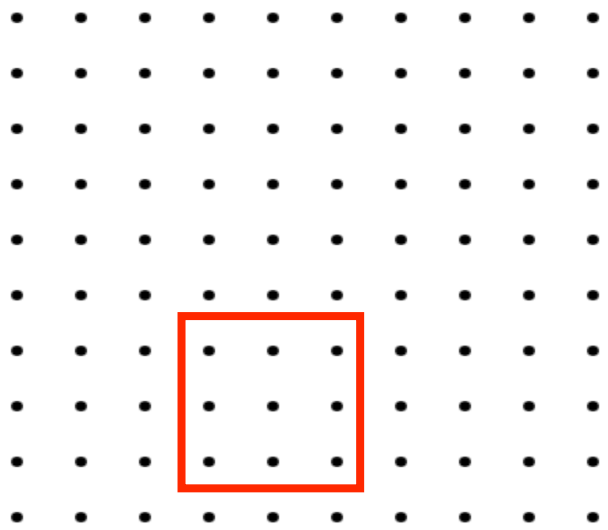
- Critique
  - creating colormaps with monotonically increasing luminance not evaluated
  - spatial frequency of data not considered



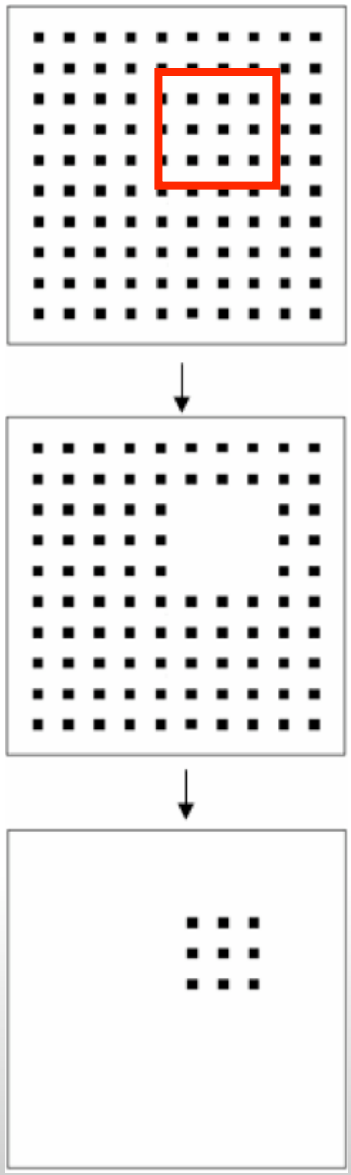
How Not to Lie with Visualization, Bernice E. Rogowitz and Lloyd A. Treinish, *Computers In Physics 10(3) May/June 1996* , pp 268-273.

Visualizing Data with Motion

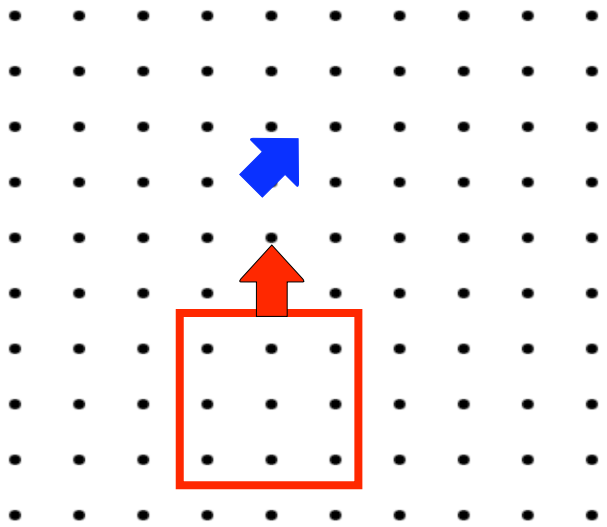
Huber, D. E. , & Healey, C. G. (2005). *Proc. IEEE Visualization 2005* , pp. 527-534.



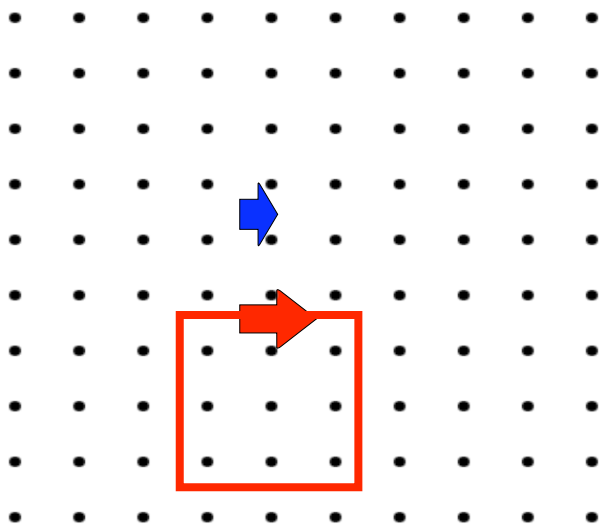
- Problem
  - guidelines for use of motion as visualization cues with MD data
- Experiments
  - dot array stimuli to evaluate motion cues:
    - flicker
    - direction
    - velocity



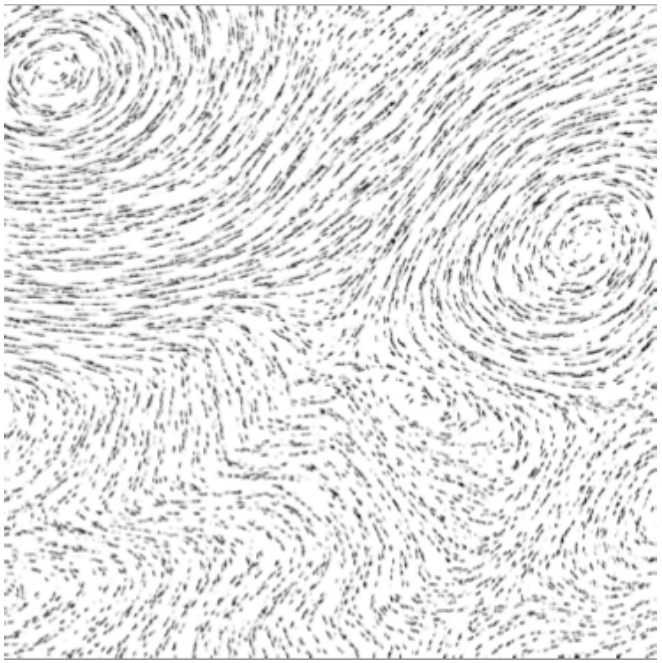
- Flicker experiment
  - target elements flicker at different rate than background elements
  - evaluated:
    - cycle length f_t
    - cycle difference ΔF
    - coherency
  - results (based on error rates, RT):
    - non-coherent error rates at chance
    - coherent trials: ΔF of 120 ms easy to detect



- Direction experiment
  - target elements move in different direction than background elements
  - evaluated:
    - absolute target motion direction d_t
    - direction difference ΔD
  - results (based on error rates, RT):
    - d_t doesn't matter
    - ΔD more than 20 degrees easy to detect



- Velocity experiment
  - target elements move at different velocity than background elements
  - evaluated:
    - absolute target velocity v_t
    - velocity difference ΔV
  - results (based on error rates, RT):
    - v_t doesn't matter
    - ΔV more than 10px/s easy to detect (0.43 degrees)

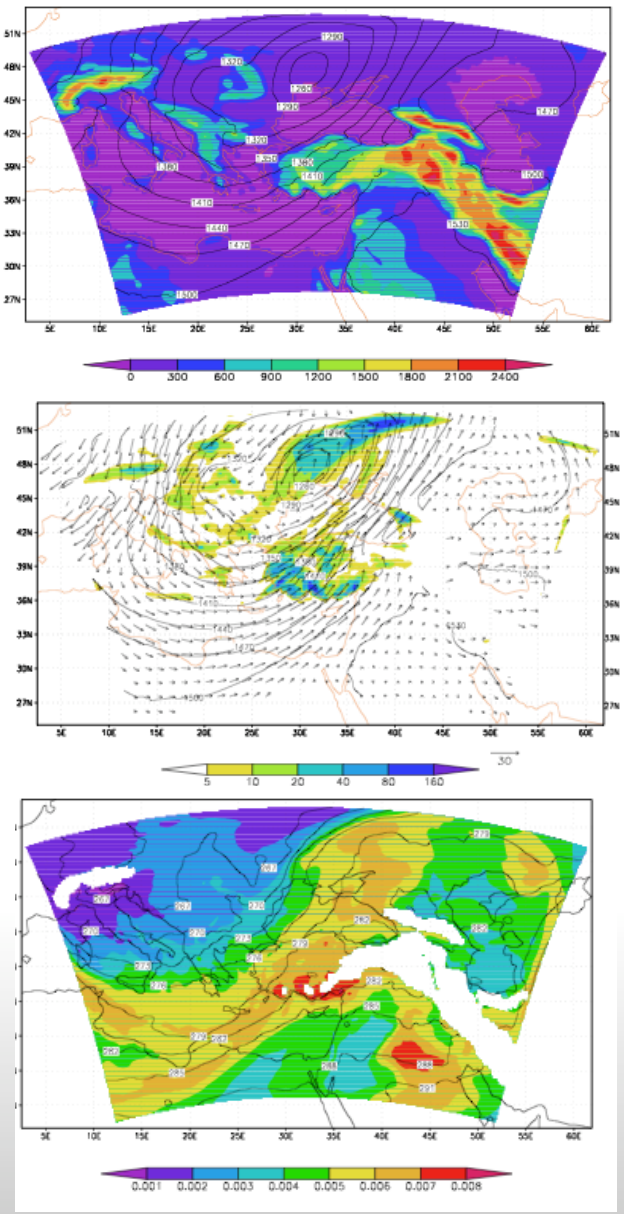


- Implications + Applications
- flow visualizations
  - highlight changes in a data set over time or space
  - temperature and pressure gradients in meteorological datasets

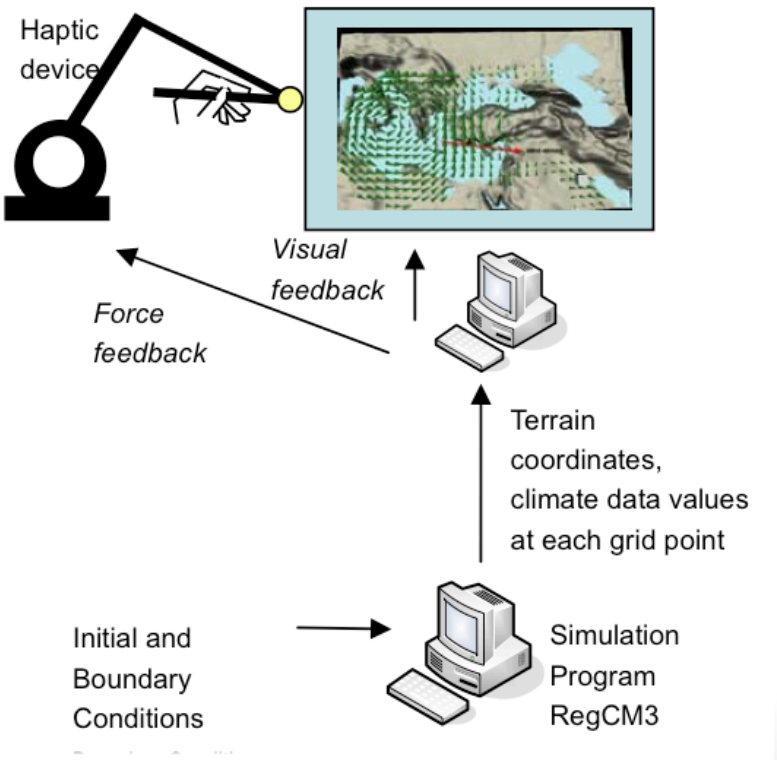
- Critique
  - interaction of motion cues not evaluated
    - possible interaction with non-motion cues
  - representative behaviour of real-world data?
    - grid layout of stimuli appropriate?
  - increased cognitive load for processing motion

Using Haptics to Convey Cause and Effect Relations in Climate Visualization

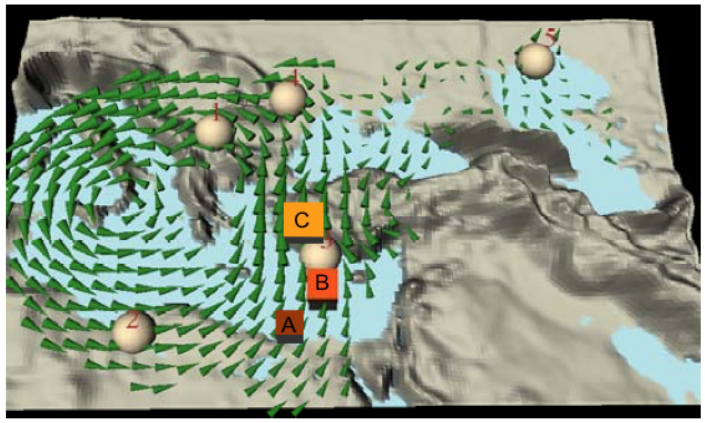
Yannier, N. , Basdogan, C. , Tasiran, S. & Sen, O. L. (2008).
IEEE Transactions on Haptics 1(2) , pp. 130-141.



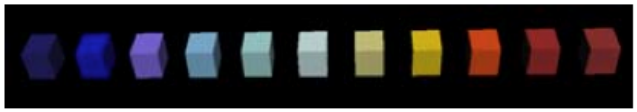
- Background & Problem
  - climate data highly multidimensional
  - multiple contour plots used to interpret data
  - difficult for learners / non-experts
  - typical displays do not target exploration, discovery, understanding cause + effect patterns



- Proposed Solution
  - CEVIZ haptic + visual interface for interactive exploration of scalar, vector, tensor fields
- Hypotheses
  - effective guided exploration of C+E patterns and relationships
  - reduced load on visual system
  - guide/confine exploration to interesting phenomena

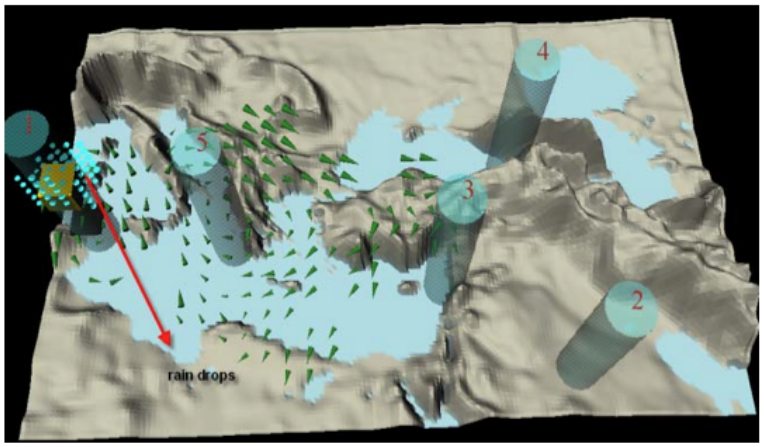


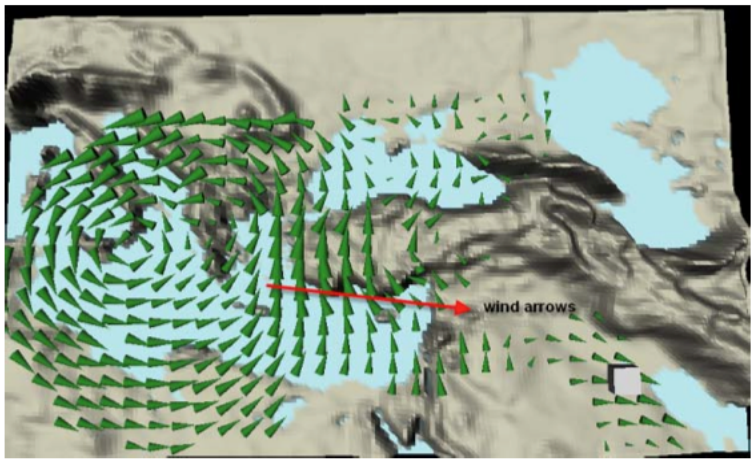
less humid more humid



cooler warmer

- Visual + Haptic Data Representation:
  - 3D mesh topography (V)
  - pressure surface (H)
  - wind (V + H: confine to path)
  - cloud water (H: bump patterns)
  - humidity + temp (V: InfoBox)
  - rain (V: cylinder)
  - vorticity and rain (wind curl) (H)





- User Study
  - V group, V + H group
  - free exploration of surface
- Evaluation
  - quizzes of C + E patterns and relationships
  - greater learning: V + H group
- Discussion
  - sig. dif. between groups
  - users naturally notice relationships without prior knowledge or interpretation

- Strength
  - different haptic encodings allow users to perceive many additional cues in multidimensional data
- Critique
  - representation of variables
  - choice of evaluation tasks
  - lacking a robust evaluation analysis

Questions?