minds and machines (2)

more connexions:
vision and touch

vision

- "I am interested in vision—the various ways that humans, animals, and computers use light to see ...
- My approach is to examine biological systems (including humans) to see how they operate, and then to look at these mechanisms from a compu-tational point of view to see if they embody more general principles ...
- These can provide a scientific basis for the design of visual interfaces that can interact with human visual systems in an optimal way."

- Ron Rensink, CS+Psych @ UBC

goals of field of vision

- *understand* how animals represent and process information carried by light, by
  - measuring and modeling visual performance in humans and other animals
  - finding ways to build artificial visual systems
  - characterizing neural mechanisms that implement visual systems
- *apply* this understanding to obtain medical, technological advances

processing of images in humans

- as a first approximation, rods and cones (sensory cells in the retina) represent image as large 2D array of light intensities
  - about 126 million sensory cells!
- this image representation is processed by brain, enabling complex cognitive functions
  - recognize a familiar face or scene
  - disambiguate overlapping objects
  - read sloppy handwriting
- how does the brain do all of this? how might image processing be partitioned into subtasks?

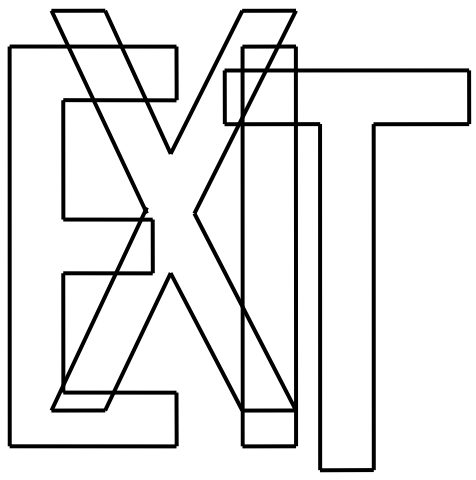

image processing tasks of brain

- possible tasks:
  - extraction of contour (e.g. sharp light intensity changes in the image)
  - extraction of motion
  - identification of object parts
- still unclear: how are these integrated to enable us to extract meaning from what we see?

psychophysical experiments

- used to test hypotheses about how the brain processes images
- e.g, Ron Rensink hypothesizes that to see changes in scenes, *attention* is necessary
- uses *flicker paradigm* to support his hypothesis - see demo at http://www.cs.ubc.ca/~rensink/flicker/index.html)
- examples: 1 2 3

vision research: summary

- ***understand*** **how we see:**
  - *hypothesize* possible subtasks performed by specialized regions of the brain
  - *test* hypotheses using psychophysical experiments
- ***apply*** **insights in new software, e.g.:**
  - present information in a way that takes users' ways of processing images into account
  - develop smart image processing systems, e.g., autostitching panoramas

touch

- "Basic research in the Touch Lab has focused for many years now on the sense of touch in humans.
- The work has examined how normally sighted and blind people come to learn about the world around them through haptic exploration and manipulation
- . . . more recently, the lab has expanded its research programmes to include the application of knowledge concerning biological touch to the design of tactile or haptic sensing systems for autonomous robots."

- Susan Lederman, Psych+CS@Queens

fingertip touch processing in humans (Lederman and Klatzky)

- lateral motion: detect texture
- pressure: detect hardness
- static contact: detect temperature
- unsupported holding: detect weight
- enclosure: detect shape and volume
- contour following: detect shape

sensory perception research at UBC: Karon Maclean

- "We are particularly oriented towards physical and multimodal interfaces. . .
- These are interfaces which will someway be found in clothing and on mobile devices, or in the furniture and walls of your home; for expressive applications . . . like computer music handlers and media control; and sensorially overloaded applications like car interiors.
- We are concerned with what these interfaces will do, how they will work, the way they'll feel, sound and look, and how users will perceive them."

– Karon Maclean, UBC CS

touch research: summary

- like vision research, interplay between *understanding* how humans process information using touch, and development of new *applications*
- *understanding* includes identifying the "units of information" obtainable via touch
- *applications* aim to move us beyond the keyboard, joystick, button, and mouse!

summary

- information processing tasks that seem trivial to humans or other animals are currently well beyond the capabilities of computers
- understanding why raises many research questions at the intersection of psychology, computer science, and other fields
- better understanding leads to better human-computer interfaces and new computer applications

resources

- cognitive science program at UBC
  - http://www.cogsys.ubc.ca/index.htm
  - interdisciplinary program of computer science, linguistics, philosophy, psychology
- Sensory Perception and Interaction Research Group, UBC
  - http://www.cs.ubc.ca/labs/spin
- touch lab at Queen's U.
  - http://pavlov.psyc.queensu.ca/~cheryl/labpage.html
- medical computing group at SFU
  - http://www.css.sfu.ca/sites/mcl/