Main point of this chapter:

Motion = Orientation in Space-Time
which motion is faster?

slow

fast

time

space

time

space
Real vs. Apparent motion

**Apparent motion** - motion percept that results from rapid display of stationary images in different locations.

**Q:** why don’t we notice the difference?
How does the nervous system encode motion?
What makes a Motion Receptive Field?

Answer: a surprisingly simple neural circuit called a “Reichardt detector”
Reichardt detector

simple summing neuron

delay line

Reichardt detector
2nd neuron has a spatially separated Receptive Field (RF), and a shorter temporal delay
Smoother Reichardt detector

Like an oriented V1 receptive field, but oriented in space-time!
Reichardt detectors respond to real and apparent motion
Figure 7.3 Constructing a neural circuit for the detection of rightward motion (Part 1)
Correspondence problem (motion):
• problem of knowing the correspondence between features in successive frames
  (which points in frame 1 are the same objects in frame 2?)

Clockwise or Counter-clockwise rotation?

https://oup-arc.com/access/content/sensation-and-perception-5e-student-resources/sensation-and-perception-5e-activity-8-4?previousFilter=tag_chapter-08

(web demo)
• **Aperture problem:**
  when a moving object is viewed through an aperture, the direction of motion may be ambiguous
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• **Aperture problem:**

- this is a problem because each *neuron* only sees the scene through a small aperture (its receptive field!)
- how can the brain figure out the “global” direction of motion?
aperture problem / correspondence problem

https://oup-arc.com/access/content/sensation-and-perception-5e-student-resources/sensation-and-perception-5e-activity-8-3?previousFilter=tag_chapter-08
building a global motion detector
Motion aftereffect (MAE): The illusion of motion that occurs after prolonged exposure to a moving stimulus

http://www.michaelbach.de/ot/mot-adapt/index.html
Motion after-effect

• Always gives rise to motion in the opposite direction of the adapting motion

• Also known as: "waterfall illusion" - stare at a waterfall; stationary objects will then appear to move upwards.

• evidence for “opponent channels” in processing motion
**Interocular transfer**: The transfer of an effect (such as adaptation) from one eye to another

- MAE: exhibits interocular transfer

**Q**: What does this tell us about where in the brain motion is computed?

- Remember: Input from both eyes is combined in area V1
Newsome and Pare (1988) conducted a study on motion perception in monkeys

- Trained monkeys to respond to dot motion displays
- **Area MT** of the monkeys was lesioned
- Result: Monkeys needed about ten times as many dots to correctly identify direction of motion
Figure 7.7 The middle temporal lobe and other regions of the cortex involved in motion perception

- Central sulcus
- Postcentral sulcus
- Motion-processing parietal cortex
- Lingual gyrus (V3)
- Primary visual cortex (V1)
- Lateral fissure
- Superior temporal sulcus

MT
Medial temporal and medial superior temporal areas (V5)
Interesting result:
electrical stimulation of area MT => monkeys report seeing motion, even when no motion present!
• optic flow
• focus of expansion
• biological motion

courtesy of R Blake

http://www.psy.vanderbilt.edu/faculty.blake/BM/BioMot.html
Motion Illusions:

- **Illusory motion**: Even static images can give you a percept of motion

- Still not understood, but believed to involve stimulation of Magnocellular pathway during eye movements
Motion Illusions:

• **wagon wheel illusion** - wheels in movies appear to spin backwards due to the multiple solutions to the correspondence problem (‘aliasing’).

http://www.michaelbach.de/ot/mot_wagonWheel/index.html

• spinning wheel
• apparent motion
• sampled at: 24 frames /sec
Motion binding

• how do local motions get combined to form a percept of global motion?

http://www.michaelbach.de/ot/mot_motionBinding/index.html
Local vs. Global Motion

- how do local motions get combined to form a percept of global motion?
Motion Illusions:

- motion induced blindness

- no known explanation (as yet)

- theory: related to brain’s ability to “fill in” defects in the visual field (like the blind spot).

New & Scholl (2008)

http://www.michaelbach.de/ot/mot-mib/index.html
Summary of concepts:

- apparent vs. real motion
- aperture problem
- correspondence problem
- Reichardt detector
- motion = “orientation in space-time”
- motion processing pathway (area MT)
- motion after-effect (“waterfall illusion”)
- inter-ocular transfer
- optic flow
- biological motion

- eye movements (saccades, smooth pursuit, vergence, reflex)
- saccadic suppression (“blindness” during saccades)
- comparator - compensating for eye movements
- illusory motion
- motion binding
- local vs. global motion