

# **Motion and Interaction**

**SIGGRAPH '99 Course:  
Fundamental Issues of Visual Perception  
for Effective Image Generation**

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## **Overview**

- **Roles of Motion Processing**
- **Mechanism of Motion Perception**
- **Using Motion to Represent Information**
- **Interactive Control**

## **Roles of Motion Processing**

- Required for Pattern Vision
- Driving Eye Movements
- Time to Collision
- Exproprioceptive Information
- Perception of Moving Objects
- Depth from Motion
- Encoding 3D Shape
- Image Segmentation

## **Characteristics of Motion Perception**

- Fundamental, independent visual process
  - motion aftereffects
  - motion blindness
- Based primarily on brightness
- Ability to interpret structure degrades in periphery
- Spatio-temporal interactions

## **Motion Pathway**

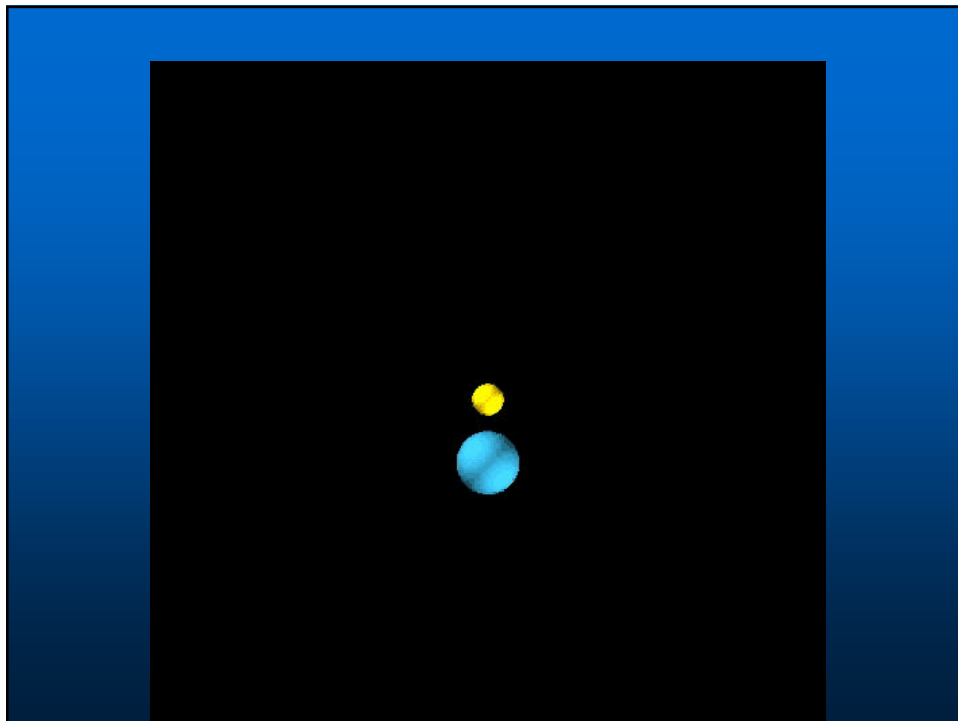
- Red and green cones
- Type A retinal ganglion cells
- Magnocellular layers in LGN
- Area 4B in primary visual cortex
  - direction selectivity
  - velocity selectivity
  - expansion/contraction of visual field
  - global rotation
- Middle temporal lobe

## **Magnocellular Division**

- Discriminates objects from one another
- Characteristics (relative to parvocellular path)
  - color : insensitive to wavelength variations
  - acuity : larger RF centers
  - speed : faster and more transient response
  - contrast : more sensitive to low contrast stimuli
- Observed characteristics of motion perception
  - color-blind: impaired at equiluminance
  - quickness
  - high contrast sensitivity
  - low acuity : impaired at high spatial frequencies

## Apparent Motion

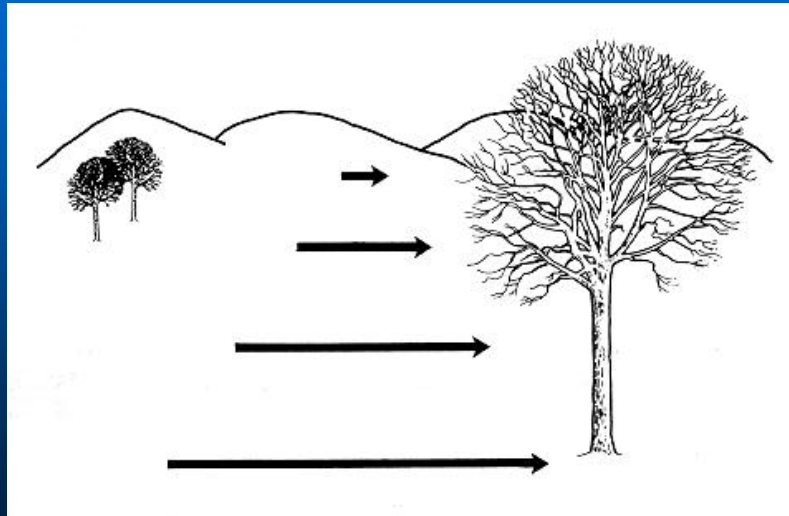
- **Def:** perception of motion without stimulus continuity (stroboscopic and cine)
- **Influences**
  - spatial frequency characteristics
  - global field effects
  - number of frames
  - expectations from reality
- **Limitations**
  - maximum of 300 msec interstimulus interval
  - decreased size constancy (max ~8 Hz)
  - decreased sense of observer motion



## Depth from Motion

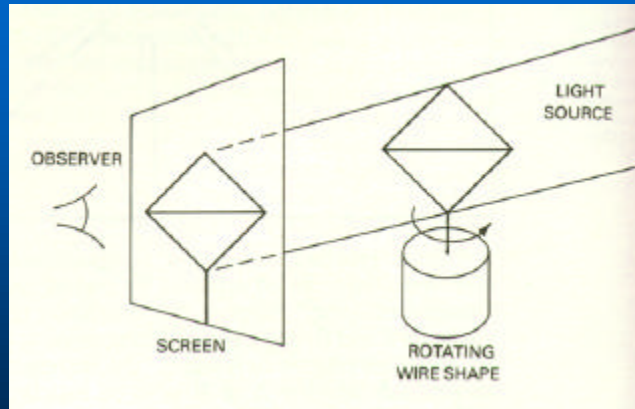
- **Motion depth cues**
  - head motion parallax
  - kinetic depth effect
  - magnitude of motion indicates relative depth
- **Applications**
  - indicating relative object positions
  - compensating for lack of other depth cues
- **Limits**
  - relative, not absolute depth
  - perceived size, perceived depth related

## Head Motion Parallax

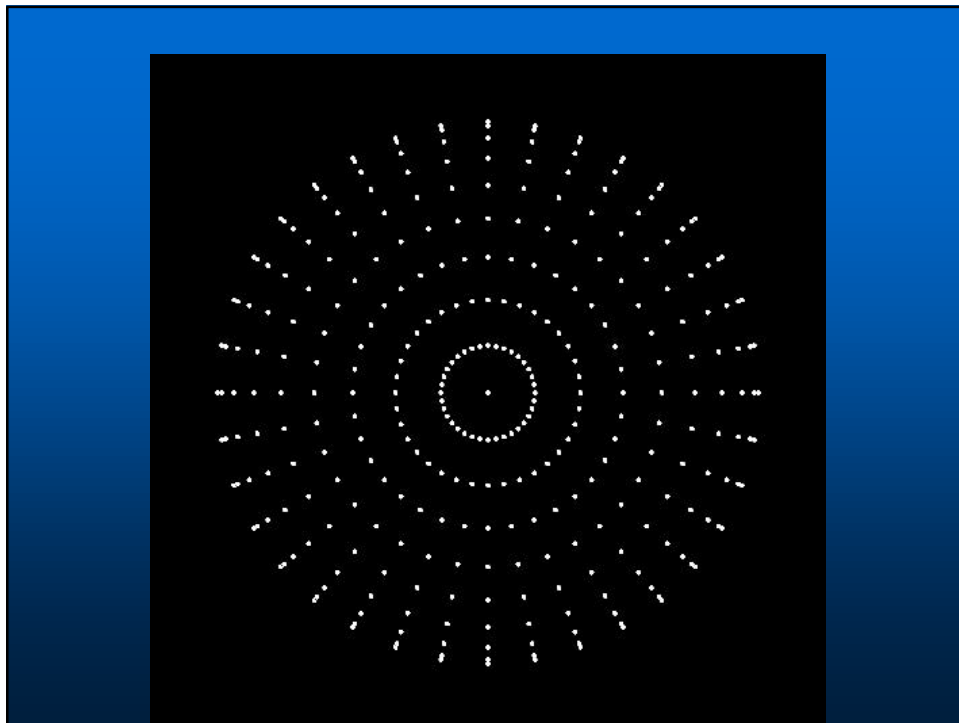


- Bruce and Green '90, p. 231.

## Kinetic Depth Effect



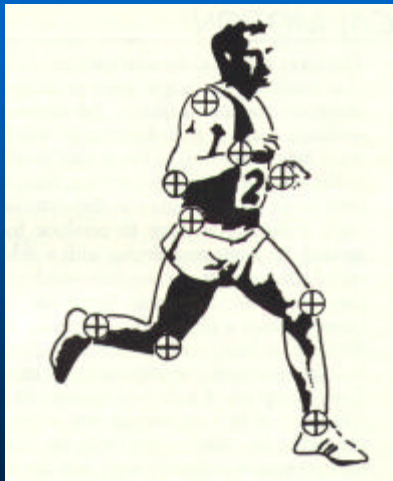
- Bruce and Green '90, pg. 162.



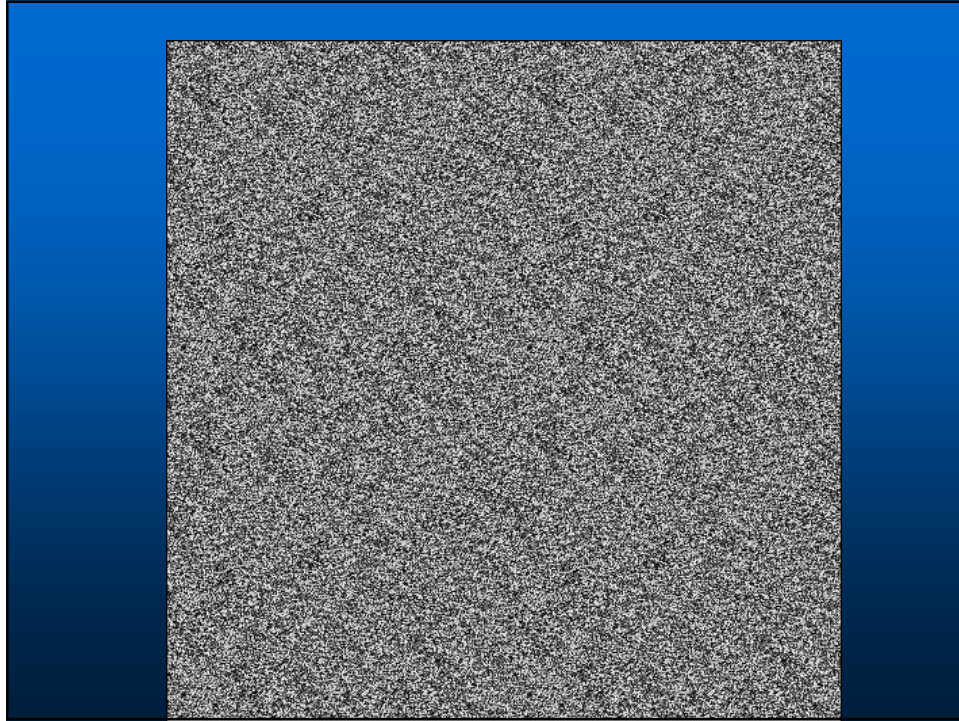
## 3D Structure from Motion

- Relative motion conveys info about 3D shape
- Rigidity assumption
- Applications
  - understanding of irregular/unfamiliar shapes
  - disambiguation of 2D projections
- Limits
  - 2 frames (large number of structured points)
  - 2-3 points (many frames)
  - 15 arc min (maximum displacement)

## Structure from Motion



- Bruce and Green '90, pg. 328.



## **Image Segmentation**

- **Discontinuities in optical velocity field indicate object boundaries**
- **Boundaries can be detected on the basis of motion alone**
- **Applications**
  - **disambiguation of complex scenes**
  - **grouping of similar objects**



## **At Equiliminance**

- Motion perception of gratings degrades
- Depth perception disappears
- Depth from relative motion disappears
- Shape from relative motion disappears

## **Interaction vs. Animation**

- Exploration vs. Presentation
  - efficiency
  - flexibility
- Active vs. Passive Participation
  - immediacy
  - control
  - development
  - understanding

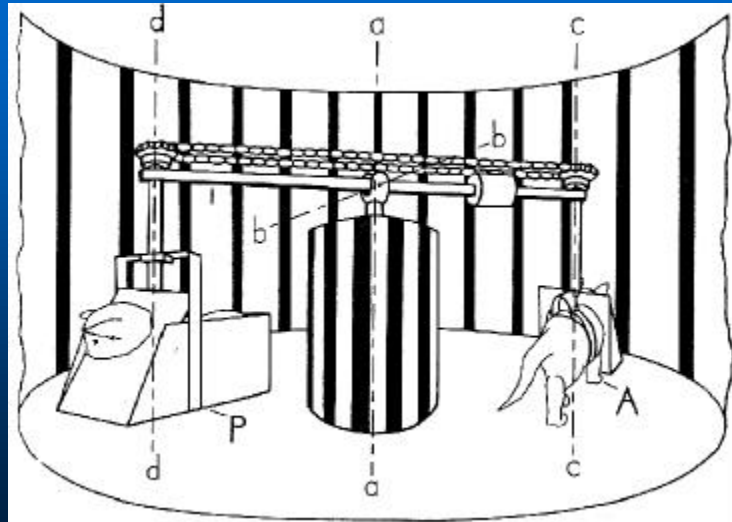
## **Interactive Control**

- **Scene**
  - viewpoint and direction
  - object position and orientation
- **Content**
  - variables
  - timestep
- **Representation**
  - techniques
  - parameters

## **Experimental Findings**

- **Control necessary for development**
  - Held and Hein '63
- **Dynamic control improves shape identification**
  - van Damme '94
  - Rheingans '92, '93
- **Control improves assembly performance**
  - Smets and Overbeeke '95
- **Differences between types of control**
  - Ware and Francke '96

## Kitten Carousel

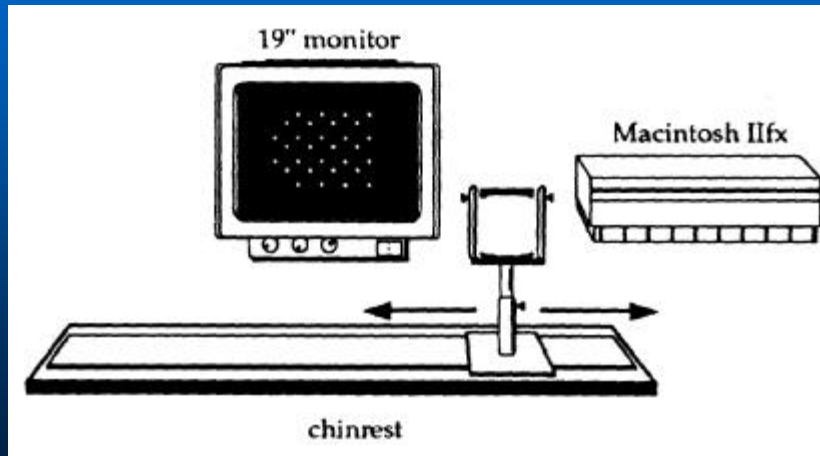


- Held and Hein '63.

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## Shape Identification



- van Damme '94, p. 18.

## Effects of Control

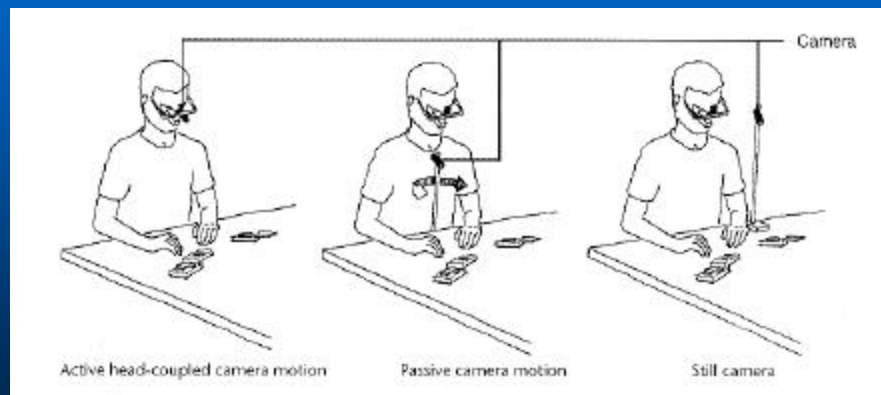
		Control		
		None	Pace	Complete
Change	Jerky	Slide Show	Slide Projector	Interactive
	Smooth	Constant Loop	Multispeed Loop	Dynamic

- Rheingans '92, '93, '97.

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## Assembly Performance

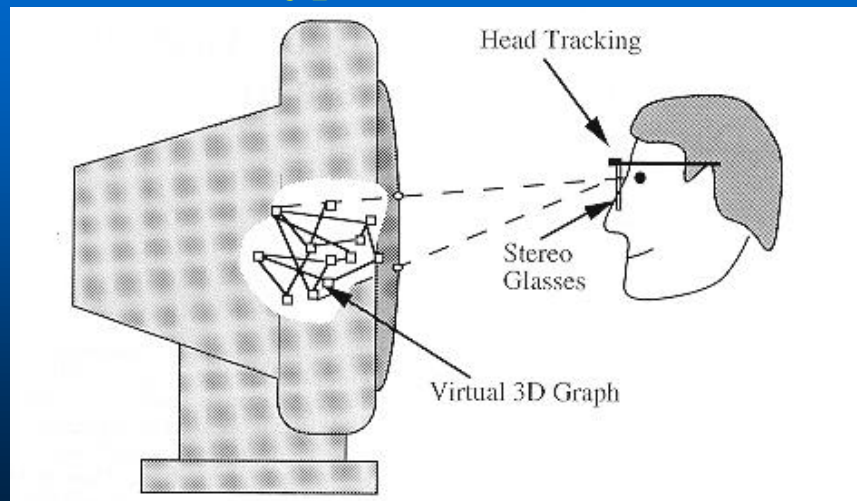


- Smets and Overbeeke '95, p. 47.

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## Type of Control



- Ware and Francke '96, p. 122.



## **Avoid**

- **Moving objects without clear boundaries**
- **Combining movement (of object or viewpoint) and shape change**
- **Motion without reference cues**
- **Mismatched spatial and temporal frequencies**
- **Temporal aliasing**