Moving Innovative Game Technology from the Lab to the Living Room

Richard Marks

Sony Computer Entertainment

Richard Marks - Background

- Parents opened a video game shop in 1983
- Avionics/medieval literature @ MIT
- Robotics/computer vision @ Stanford/MBARI
- PlayStation R&D for 13 years
  - computer vision
  - physical simulation
  - man-machine interfaces
  - experience engineering
- **EyeToy, PlayStation Eye, PlayStation Move**

Video games are a serious business

- For the last 8 years, video game sales revenues have exceeded box-office receipts
- 56% of US households own a current-gen video game console
- Nearly half of US children ages 6-12 own a Nintendo DS

- Over 150 US universities offer video game programs/degrees

- EyeToy franchise earned >$600 million revenue
- PlayStation Move has earned >$1billion revenue

Video games incorporate serious technology

- Graphics
- Processing
- Display
- Input
- Future trends

- Video games offer a unique platform for pursuing bleeding-edge technology

Graphics

- Real-time 3D driving force
  - Voodoo graphics 3D card
    - 2M triangles/sec, 40Mtexels/sec
  - Nintendo 64:
    - “SGI workstation in your living room”
  - PlayStation 2
    - Embedded DRAM – 2560 bit RAM bus
    - “Toy Story in your living room”
  - Xbox 360:
    - 500M triangles/sec, 8Gtexels/sec
  - PS3: Quantic Dream – “Kara”

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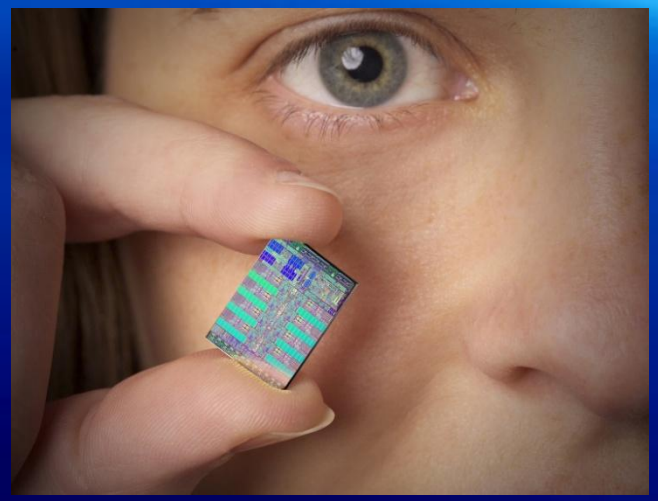
Processing

- Driving force for price/performance
  - Benefit from all forms of parallelism
  - Games often used as PC benchmark
  - Examples: Emotion engine, Cell processor
- Cloud computing
  - Gaming is pushing boundaries on using cloud for real-time interaction



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Display

- Home 3D
  - Fully interactive 3D
- Dual View
- Portable 3D
  - 3DS – glasses free, 3d strength slider
- Immersive
  - HMD (Head Mount Display)

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Input

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Degree of interaction

- Games previously….

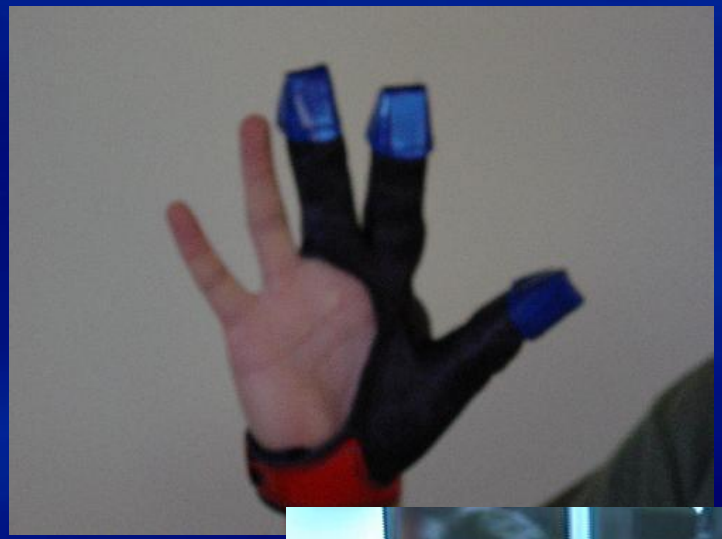
"L1 □ △" → PS2

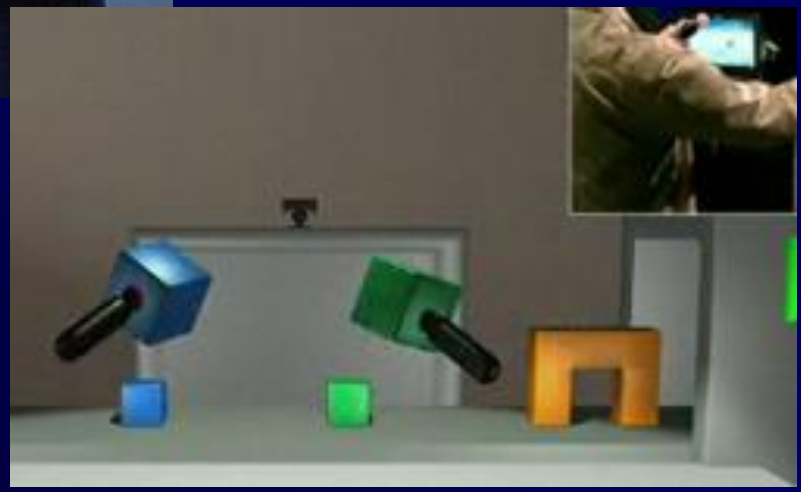
- Games now….

Cameras
Microphones
Gamepad
Inertial
Etc.

→ PS3 → "42"

From Lab….





...to Living Room

From Research....

...to Product Launch

EyeToy

- CMOS sensor and CMOS USB1.1/compression chip
  - –320x240, 60 frames/sec MPEG I-frames
  - –Automatic or manual exposure, gain, white balance
  - –Controllable compression settings
- Lens
  - –56 degree diagonal FOV
  - –1.5 F/#
- 16 kHz, 16-bit microphone

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EyeToy

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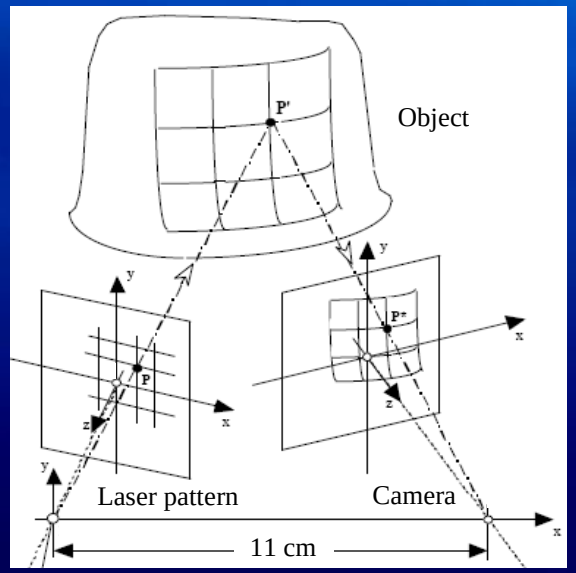
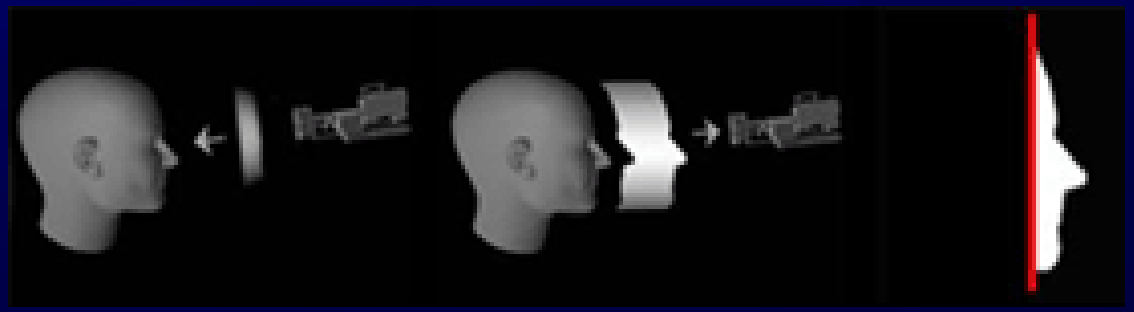
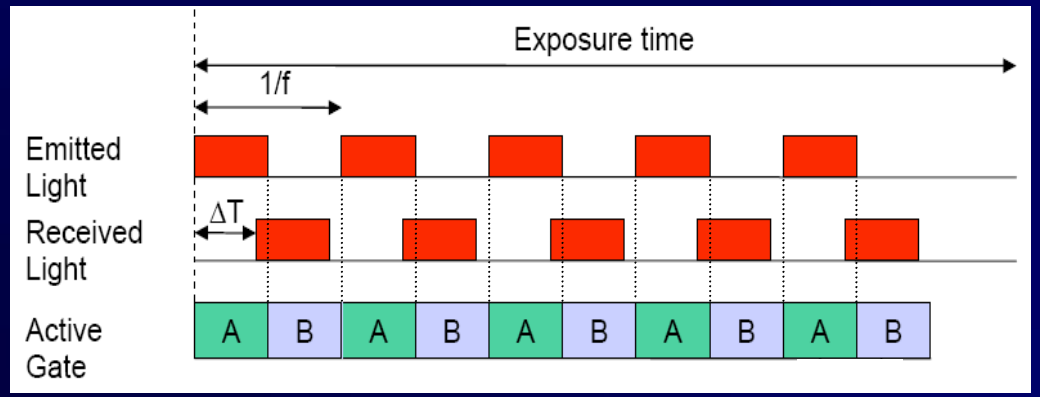
Depth camera research

- Per-pixel depth sensing
  - Active illumination
  - Triangulation
  - Time-of-flight







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Depth camera research

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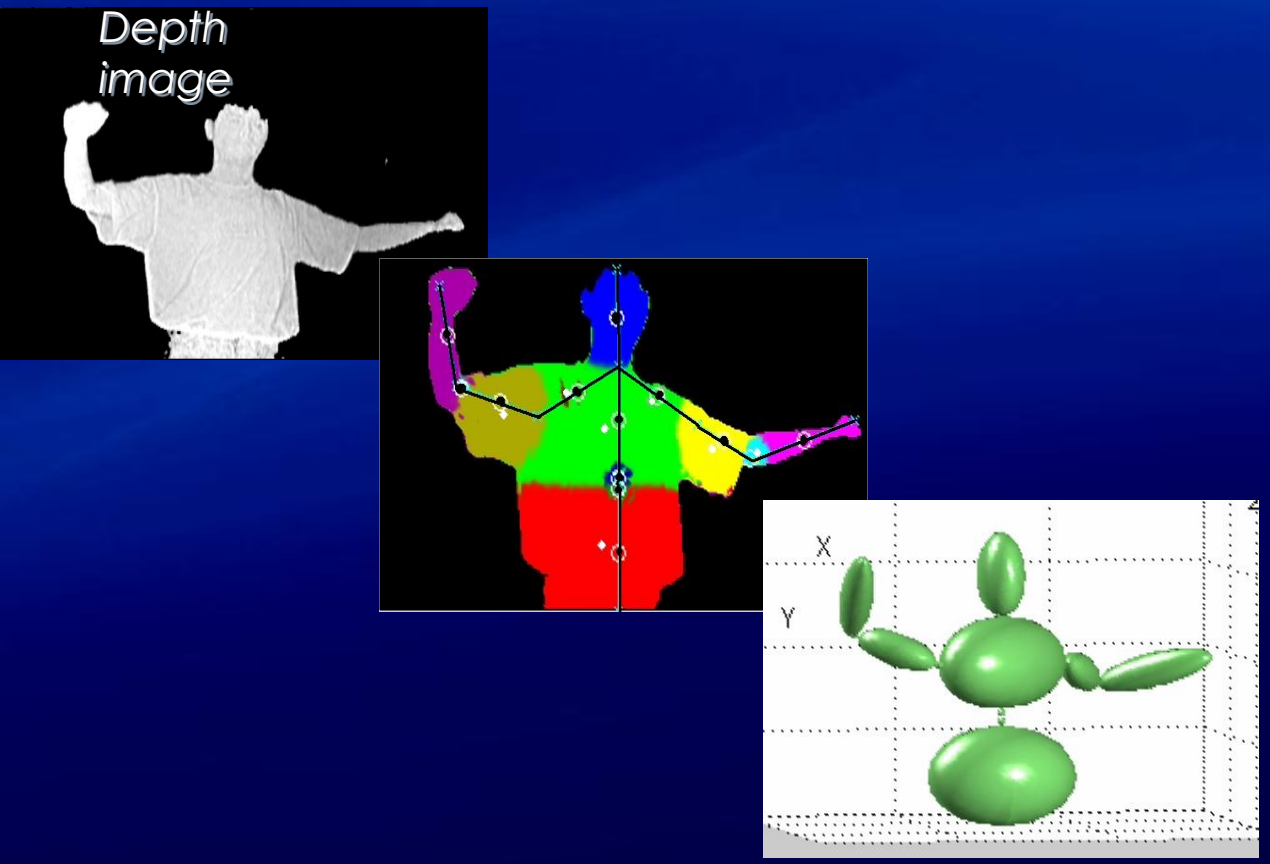
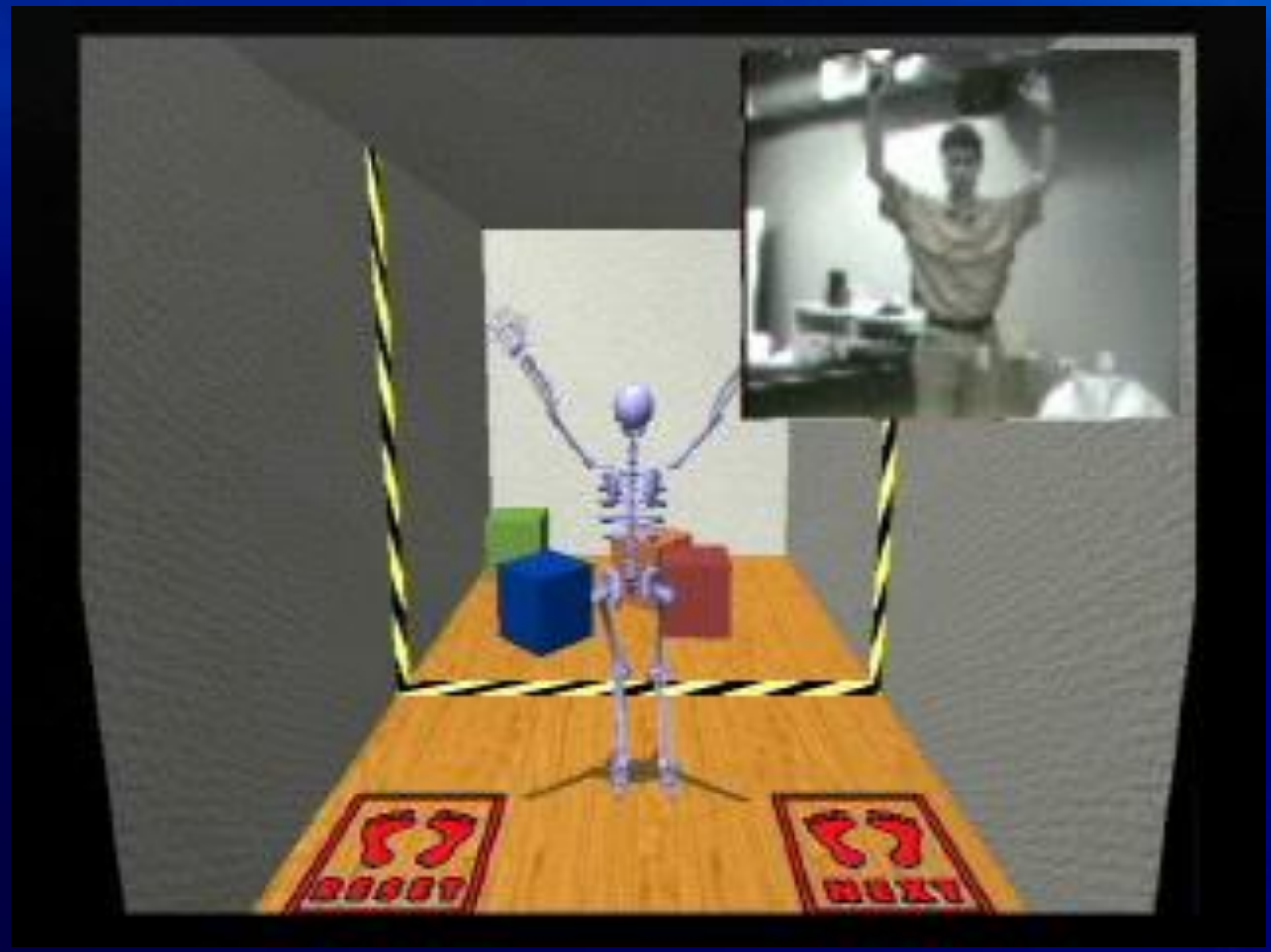
Depth camera research



Real-time Motion Capture



See http://kinecthacks.com

PlayStation Eye

- ¼” CMOS sensor
  - 640x480, 60 frames/sec raw
  - 320x240, 120 frames/sec raw
  - 6 micron pixels!
  - Increased low-light sensitivity
- Uncompressed Video
  - No artifacts
  - Software demosaicking
  - USB bulk transfer (low CPU overhead)
- 56/75 degree dual-FOV lens
  - <1% distortion, fixed focus (0.5m to 10m)
- Omni-directional 4-microphone linear array
  - 48 kHz, 16-bits per channel

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Improved Tracking

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PlayStation Move

- New spatial controller for PS3
  - Provides spatial 3D input (position and orientation)
  - Works with PlayStation Eye
  - Tracks precisely and responsively (low latency)
  - Enables new kinds of entertainment experiences

From Lab to Living Room

- Conceptual prototype
- Functional prototype

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- Engineering prototype

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- Design prototype

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- Mass production

Hardware description

- 45mm sphere with internal RGB LED
- 3-axis accelerometer, +-6g
- 3-axis gyro, +-3000deg/sec
- 3-axis magnetometer
- 8-bit rumble
- Bluetooth wireless, Lion rechargeable battery
- Analog T button, large Move button
- One-handed “Handle” design

How it works

- PlayStation Eye is used to track the 3D position of the sphere
  - Detection based on color
  - Shape-based model fit to edges
- Data fusion using Unscented Kalman filter
  - Full state recovery and bias estimation
  - Exploits sensor redundancy

Sphere Tracking

- Sphere projects to a unique ellipse in the PS Eye video
- Color segmentation for detection
- Edge-based model fitting to recover ellipse parameters
- Issues: occlusion, motion blur, rolling shutter, sphere/LED variance, etc.

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Future trends

- Input is still a hot area
- Life gaming
  - Nike Fuel
  - Google glasses
  - Four Square
- Total immersion
  - Head mount displays
- Haptic feedback
  - Rich vibration, electrostatic

Thank you!

- Demo
- Q&A

Research models

- Push
  - Research group pushes technology out of lab and into product groups
  - Tough because product groups have schedules
  - Example: EyeToy
- Pull
  - Tends to be evolutionary, not revolutionary
  - Less freedom, but certainty of usefulness
  - Example: PlayStation Voice Recognition
- Stockpile
  - What do we do with this? Don’t know, save it for later.
  - Most common model for large research groups