Self-Calibrating Optical Object Tracking using Wii Remotes

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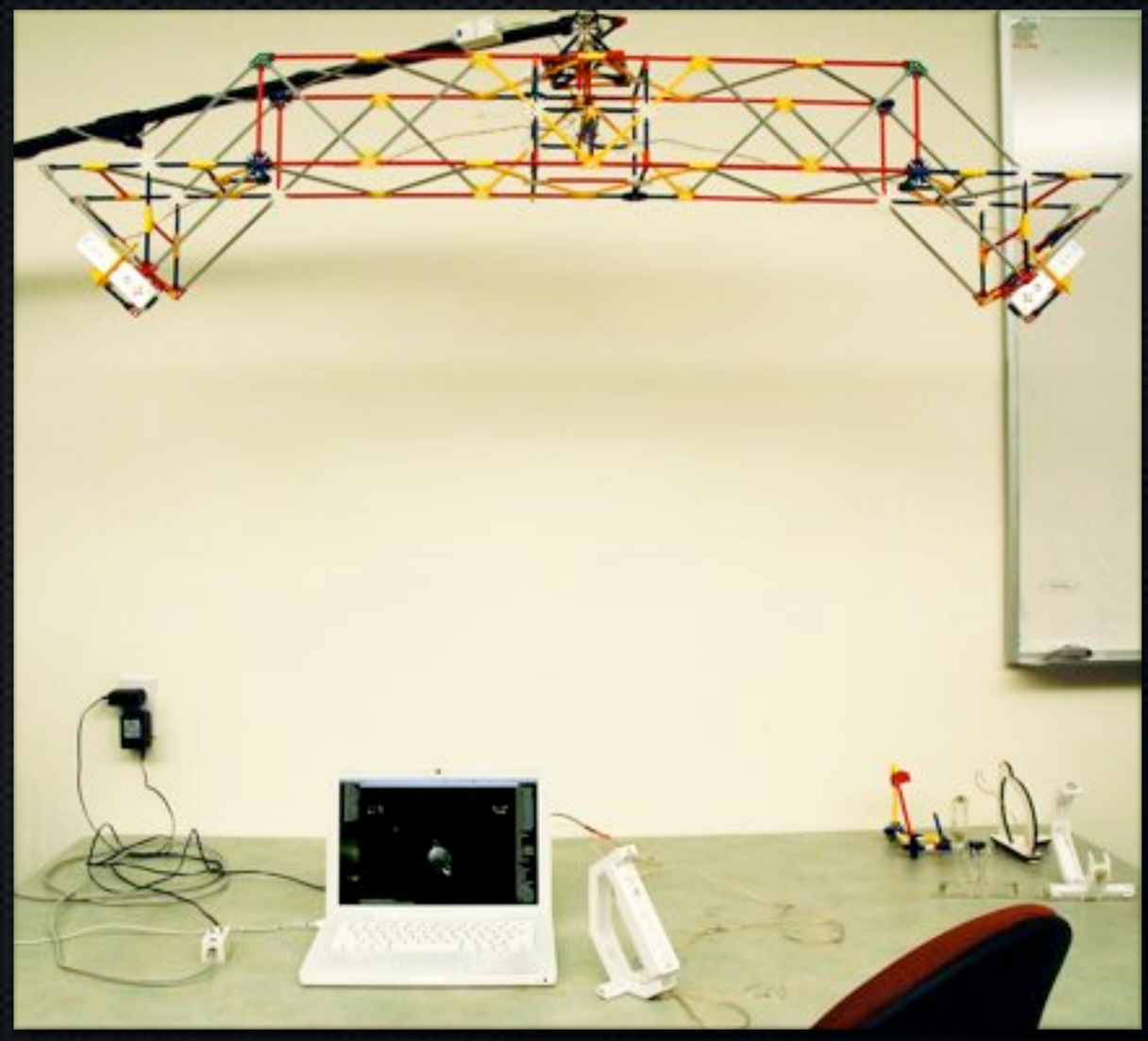

The Wii Remote

- Released in 2006
- Video game controller
- Bluetooth connection
- 3-Axis Accelerometer
- Extention Port
- Point-tracking IR Sensor

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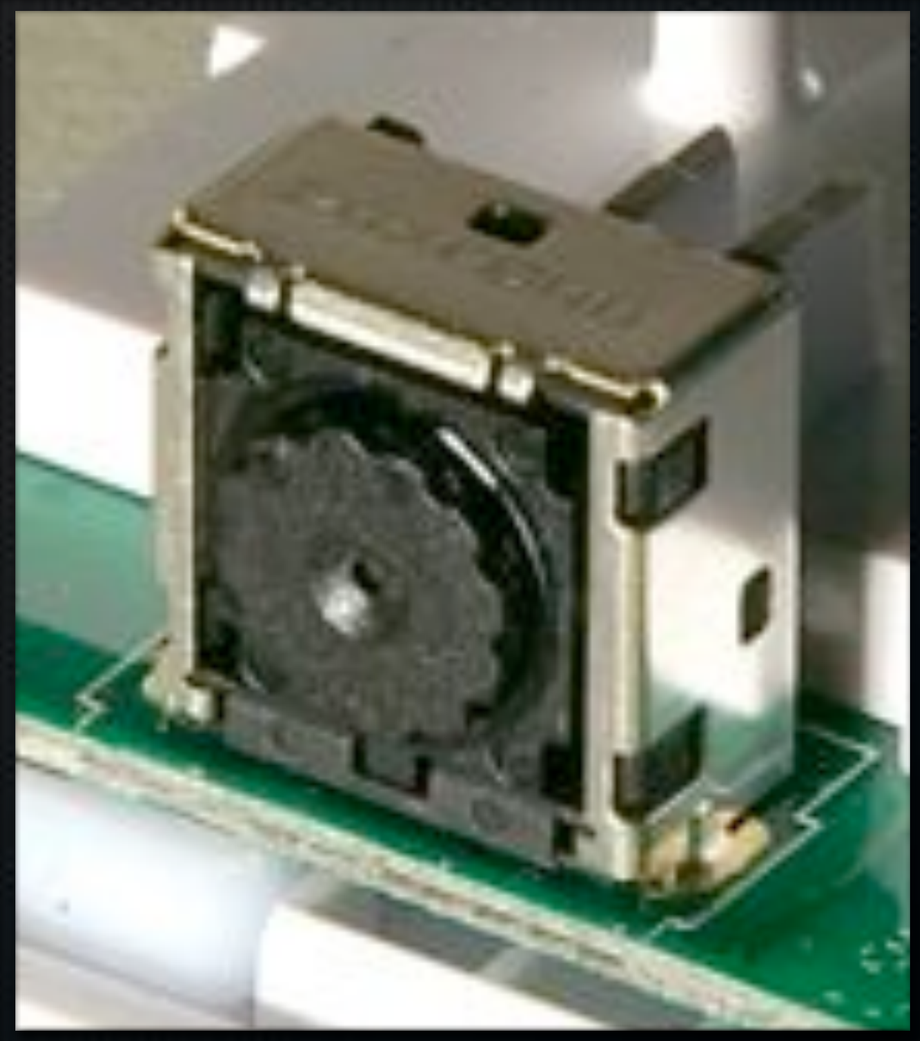
The Wii Remote's IR Sensor

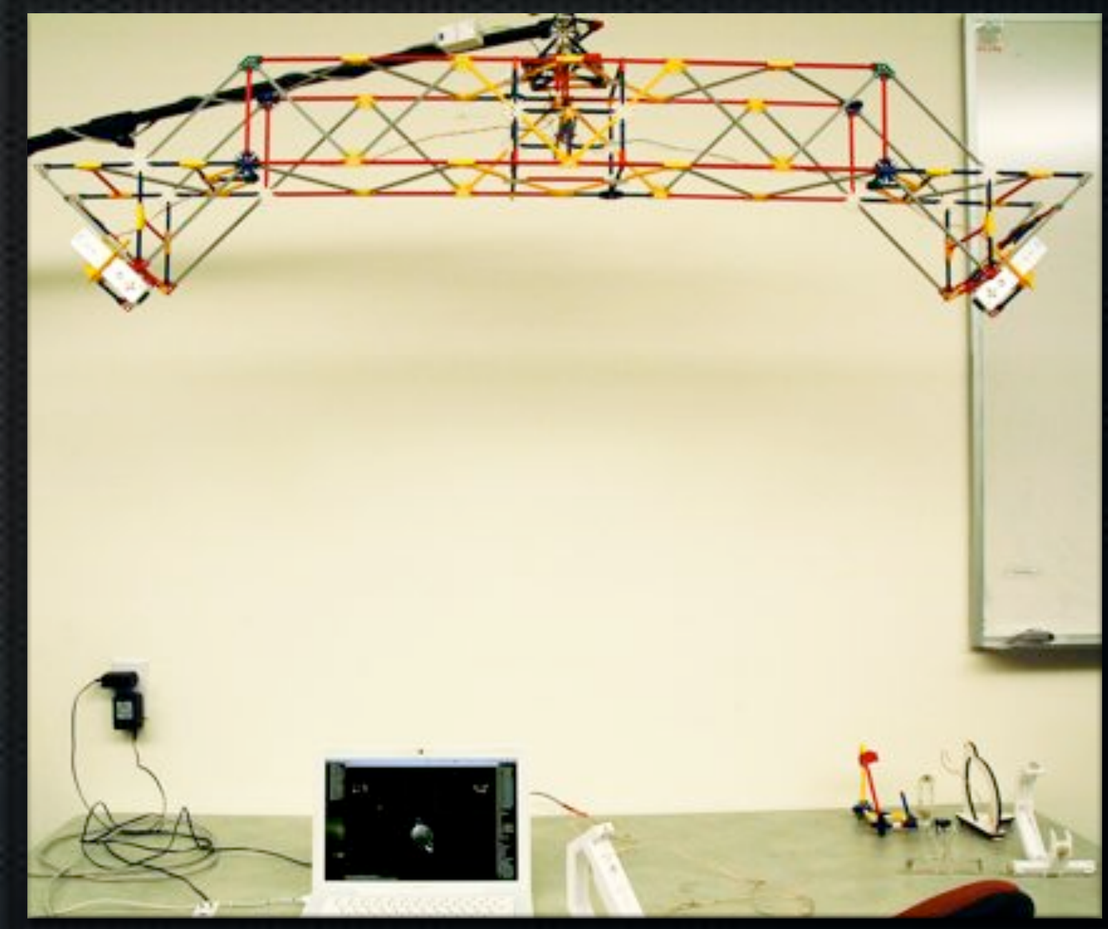
- Tracks up to 4 points'
  - position
  - area
  - intensity
  - bounding box
- Frame rate: 100Hz+
- Effective resolution: 1024x768
- Peak sensitivity: ~940nm



http://www.free-track.net/forum/index.php?showtopic=482

Object Tracking

- Two stationary Wii Remotes
- “Artifact” with markers (IR LEDs) in known geometry
- System tracks artifact’s position and orientation
- Continuous tracking is easy, initialization is hard



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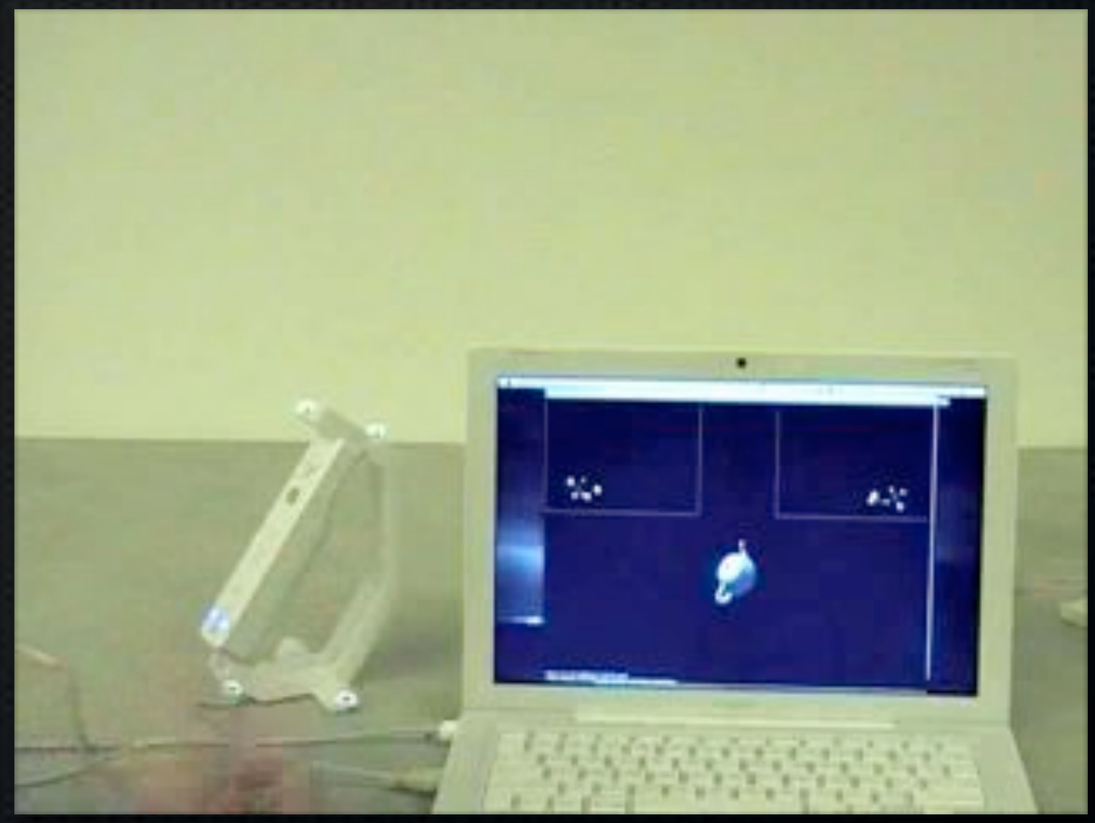


Initialization

- Where are the cameras
- 12 degrees of freedom, 6 for each camera
- 12-16 constraints, 2 for each observed point
- However, the correspondence between observed points and markers on the artifact is not known
- Additional constraints are available - acceleration

Accelerometer-Assisted Initialization

- At rest, accelerometer measures pull of gravity
- Wii Remote provides calibration to within 0.05g
- 4 unambiguous constraints - pitch and roll of cameras
- Insufficient alone
- Still need to determine marker to observation mapping

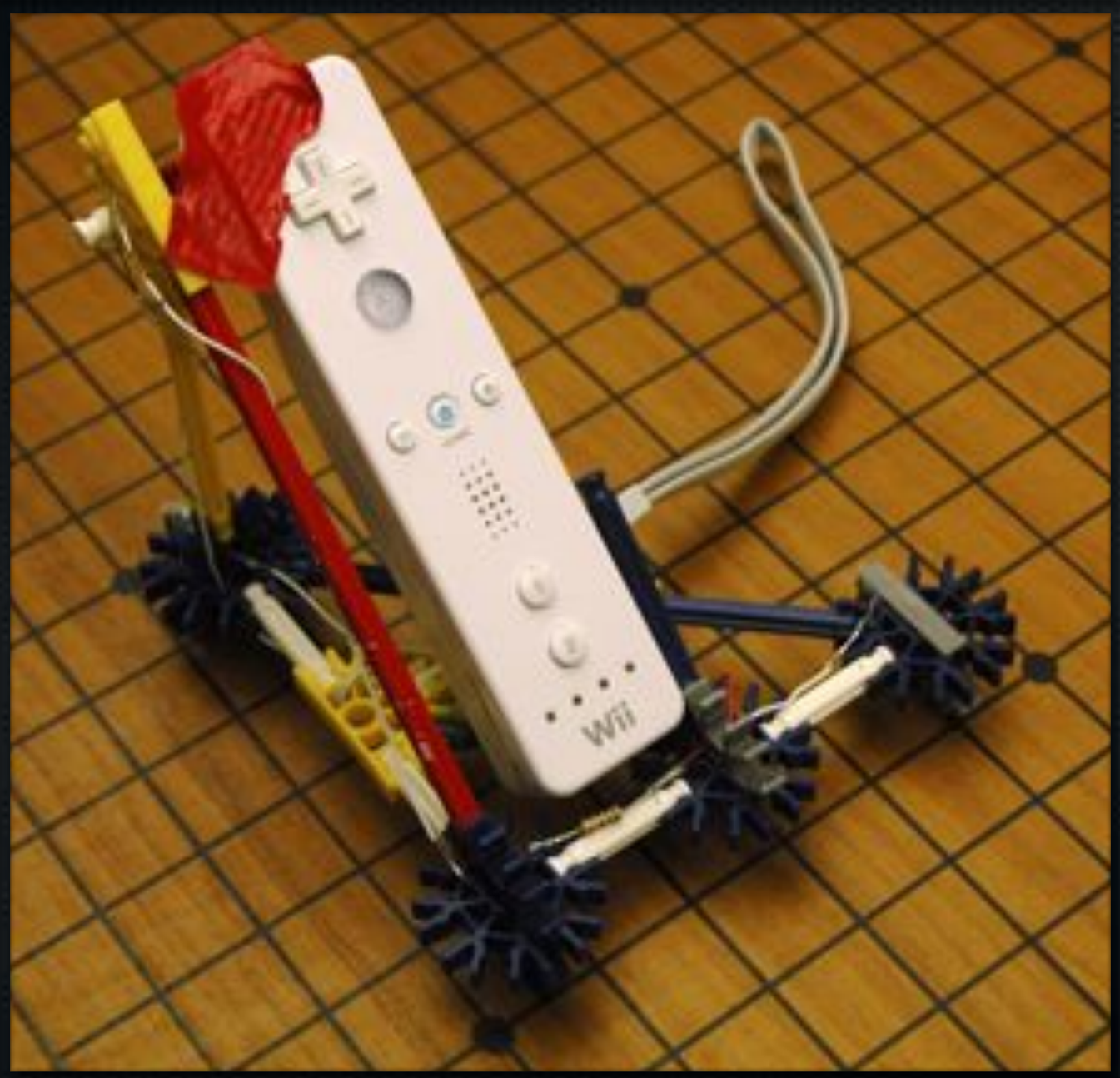
Initialization

- Potential solutions are the cartesian product of:
  - subset of 3 observed points (≤4)
  - face of octahedron (8)
  - rotatation of that face (3)
  - solutions of P3P problem (≤4)
- ≤384 putative poses per camera
- Pick best using accelerometer and 4th observed point

Tracking

- Gradient descent optimization
- Metric: RMS image space distance from each observed point to nearest marker
- Reinitialize if optimized error is too large
- Refine calibration when stable and low error

Evolution of the Artifact



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Questions?