CSE 190: Virtual Reality Technologies

LECTURE #18: OPTICAL TRACKING

VR Content Presentations

Ran Tao: Virtual Virtual Reality
- https://youtu.be/KOYXeqAAuxU

Andrew Hwang: Reality Hacker VR
- https://www.youtube.com/watch?v=r3pXEtpLDLI&t=4s

Mou Sun: Skydiving 360
- https://www.youtube.com/watch?v=a54H2V06dqw

Clark Wu: 360 Google Spotlight Rain Or Shine
- https://www.youtube.com/watch?v=QXF7uGfopnY

Garrett Brush
- https://www.youtube.com/watch?v=e5b-l__or0g
- https://docs.google.com/presentation/d/1pnB3XnurBCXxfk2PteOja-STU0YjoErBKMG0YQB8UbY/edit?usp=sharing

Pedro Coutin Portuondo: Stunning 360 Paramotor Flight
- https://www.youtube.com/watch?v=pHxzmc7_5Vg

Announcements

Final Project

- Blog #2 due Monday night
- Presentations next Tuesday 3-6pm
  - Slide shows 3-4pm: Google Slides
  - Even hour teams 4-5pm
  - Odd hour teams 5-6pm

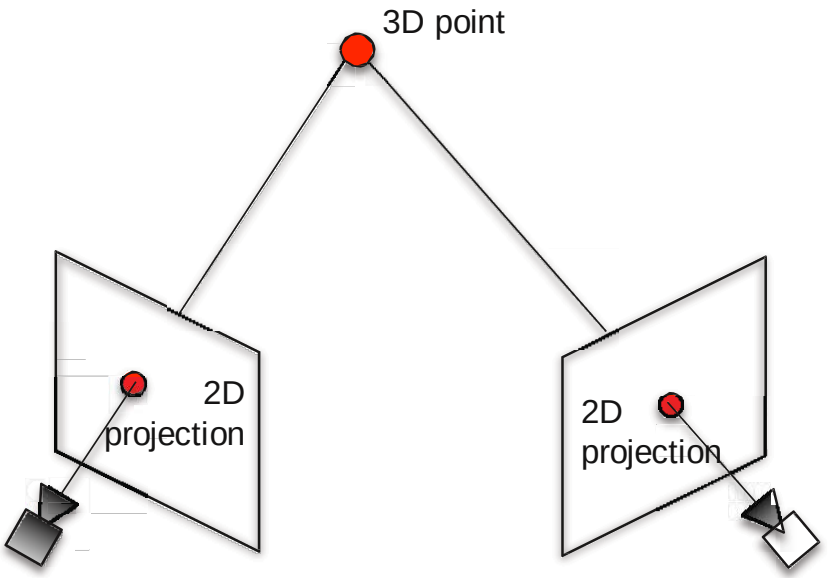
TA/tutor evaluations

CAPE

Positional Tracking - Optical

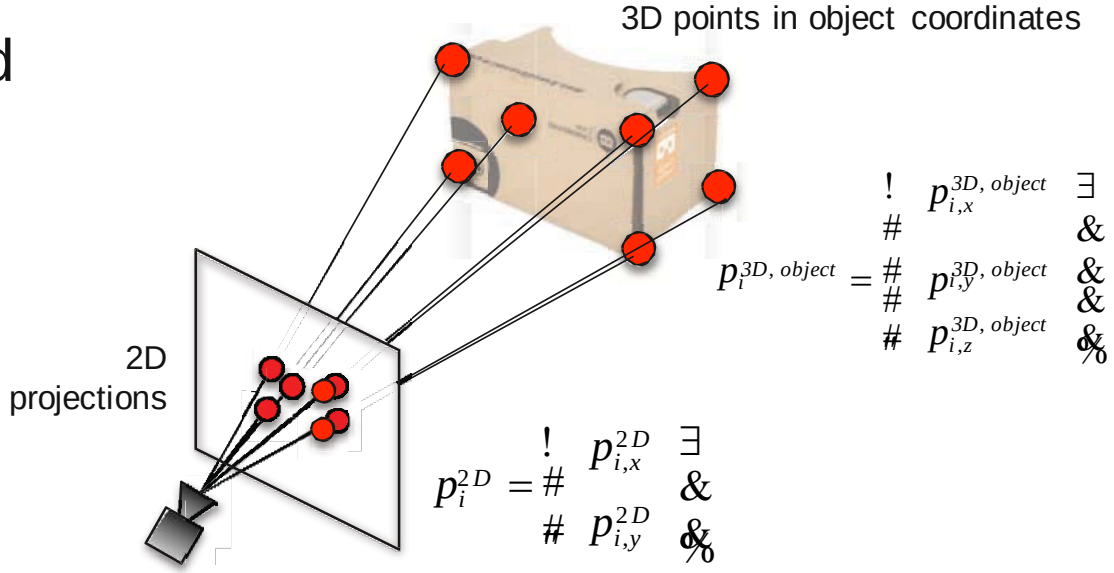
- for tracking individual 3D points, multi-camera setups usually use triangulation

- this does not give us the pose (rotation & translation) of camera or object yet



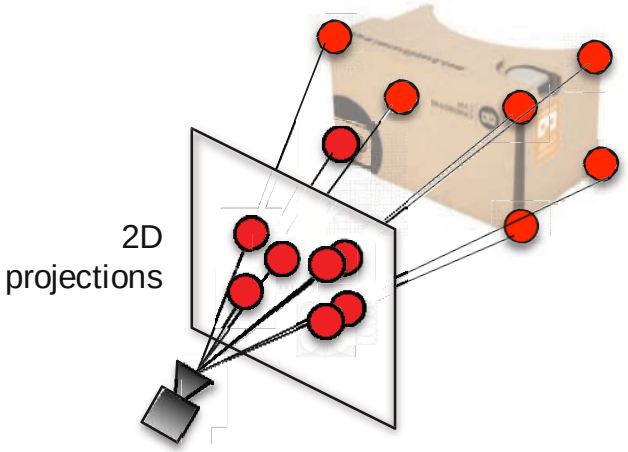
Positional Tracking - Optical

- for pose tracking, need to track multiple 3D points with known relative coordinates!



Positional Tracking - Optical

- when object is closer, projection is bigger

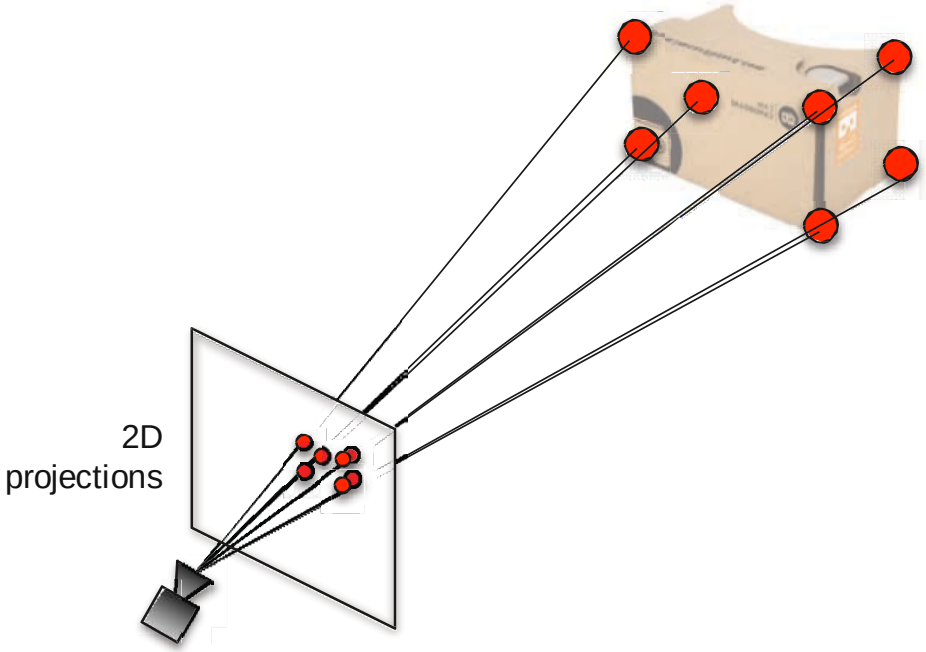


Positional Tracking - Optical

- when object is father, projection is smaller

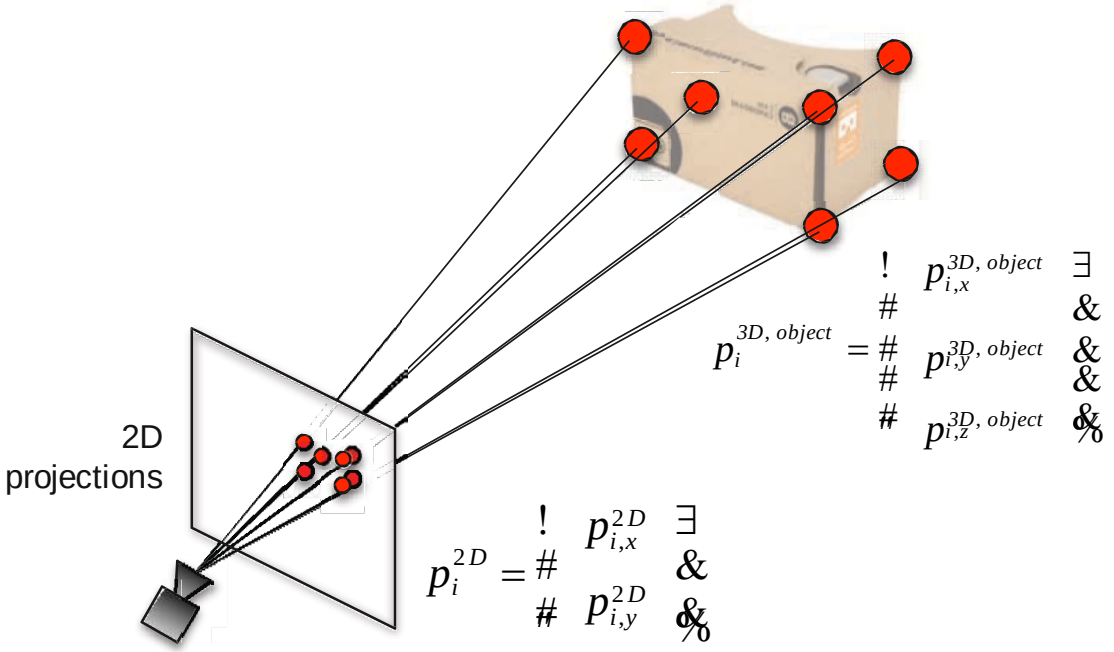
... and so on

...



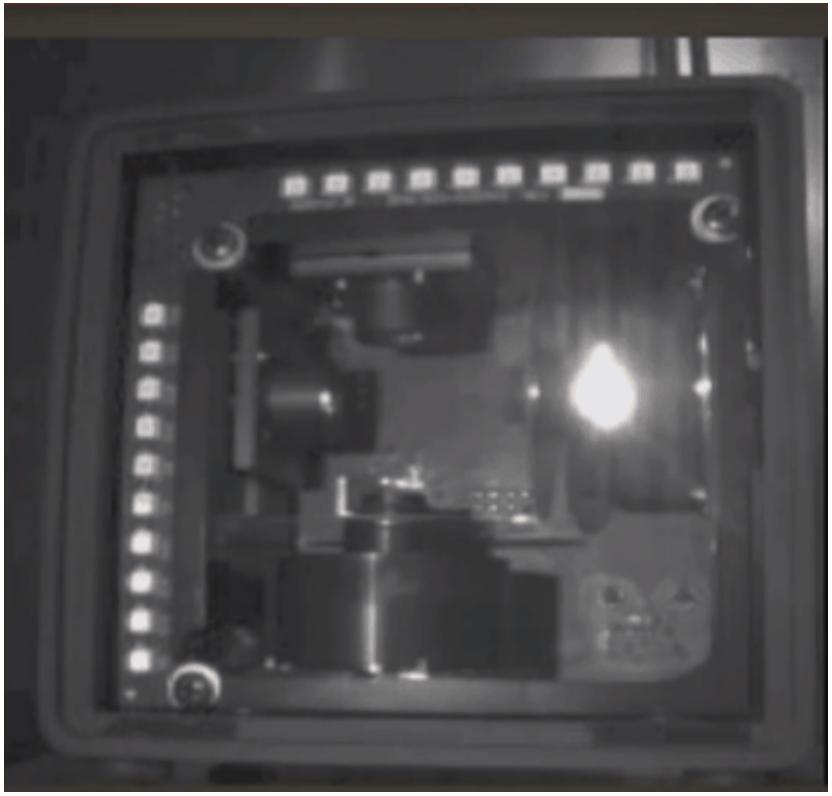
Positional Tracking - Optical

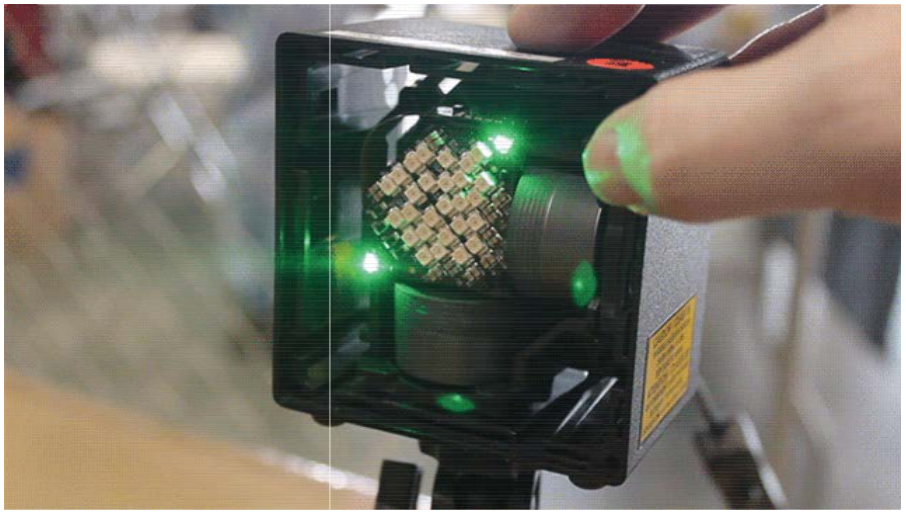
- pose estimation via optimization!
- nonlinear least squares problem



$$\underset{\{R,T\}}{\text{minimize}} \left\| \underbrace{\left(p_1^{2D}, p_2^{2D}, \ldots, p_N^{2D}\right)}_{\text{observed 2D points}} - \underbrace{f\left(p_1^{3D,\,object}, p_2^{3D,\,object}, \ldots, p_N^{3D,\,object}, \underbrace{R,t}_{\text{unknown pose}}\right)}_{\text{known 3D points}} \right\|_2^2$$

HTC Lighthouse



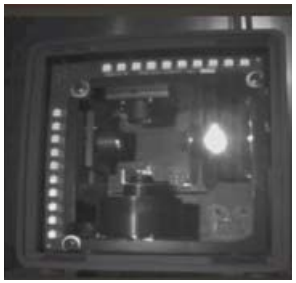


http://gizmodo.com/this-is-how-valve-s-amazing-lighthouse-tracking-technol-1705356768

HTC Lighthouse

https://www.youtube.com/watch?v=J54dotTt7k0

HTC Lighthouse



<u>important specs</u>:

- runs at 60 Hz
    - i.e. horizontal & vertical update combined 60 Hz
    - broadband sync pulses in between each laser sweep (i.e. at 120 Hz)
- each laser rotates at 60 Hz, but offset in time
- useable field of view: 120 degrees

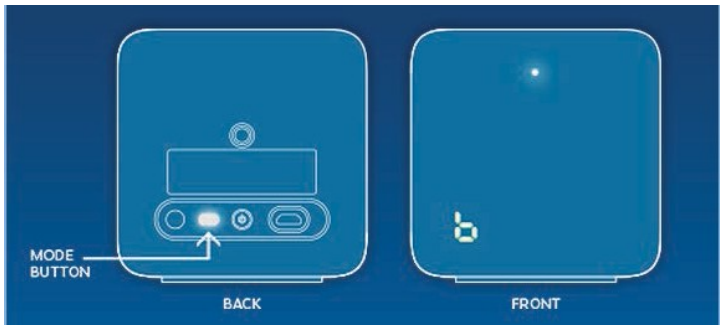
HTC Lighthouse – Base Station

- can use up to 2 base stations simultaneously via *time-division multiplexing* (TDM)
- base station modes:

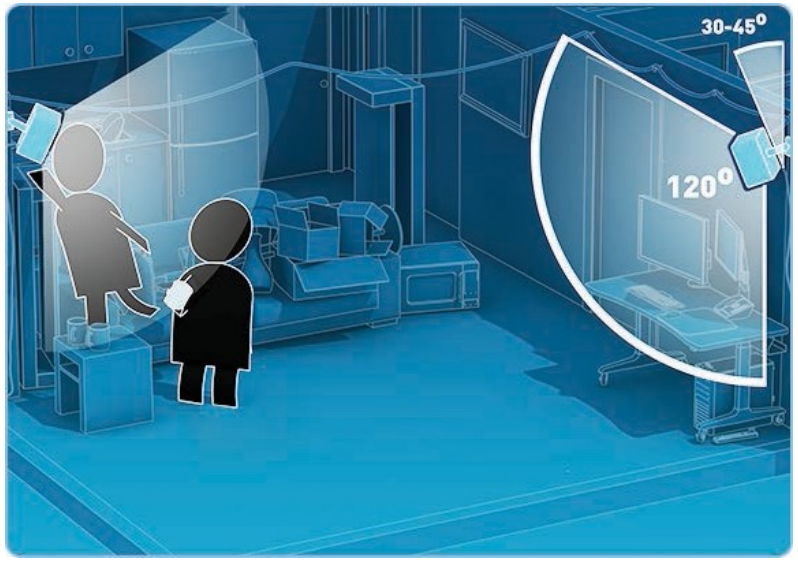
  A: TDM slave with cable sync

  B: TDM master

  C: TDM slave with optical sync



HTC



HTC Lighthouse – Base Station

- sync pulse periodically emitted (120 times per second)
- each sync pulse indicates beginning of new sweep
- length of pulse also encodes additional 3 bits of information:

Name	skip	data	axis	length (ticks)	length (µs)
j0	0	0	0	3000	62.5
k0	0	0	1	3500	72.9
j1	0	1	0	4000	83.3
k1	0	1	1	4500	93.8
j2	1	0	0	5000	104
k2	1	0	1	5500	115
j3	1	1	0	6000	125
k3	1	1	1	6500	135

- axis: horizontal or vertical sweep to follow
- skip: if 1, then laser is off for following sweep
- data: data bits of consecutive pulses yield OOTX frame

https://github.com/nairol/LighthouseRedox/blob/master/docs/Light%20Emissions.md#sync-pulse

HTC Lighthouse – Base Station

- OOTX frame used to communicate between base stations or with sensors
- can send calibration data and all kinds of info
- detailed info here: https://github.com/nairol/LighthouseRedox/blob/master/docs/Light%20Emissions.md#sync-pulse