

(Depth) Cameras

Tue, August 4 (Week 7)

AR Devices

Of the 1990s: no camera (and no computer to do the computation for)

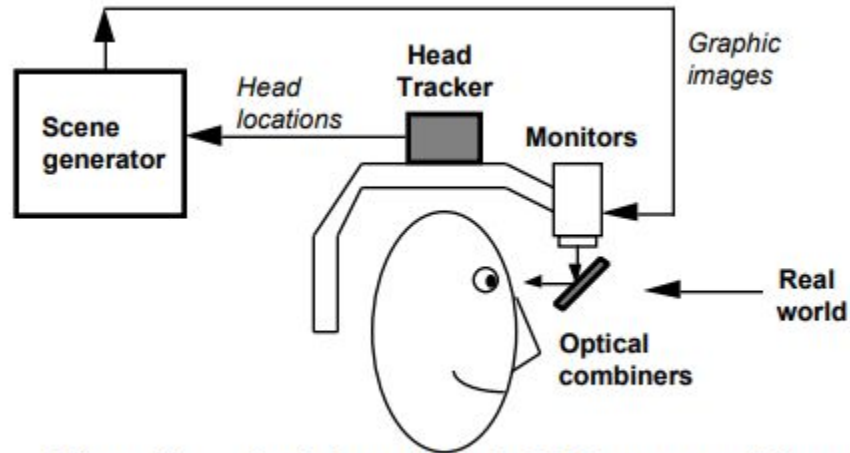
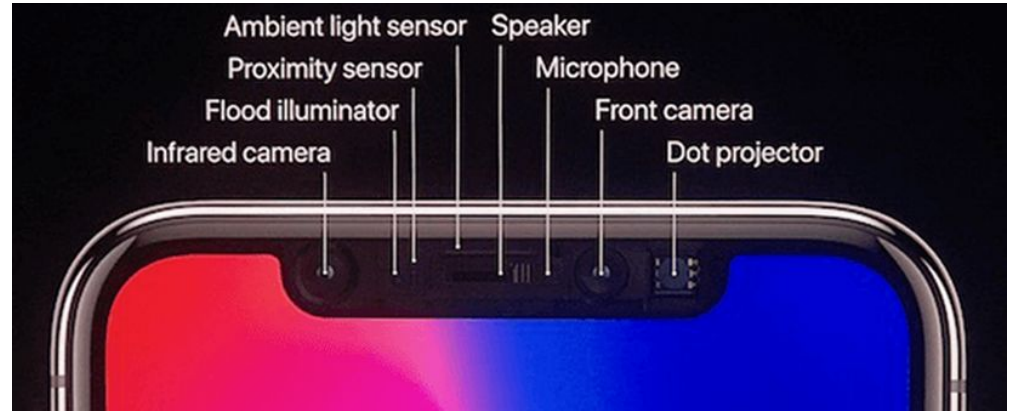


Figure 11: Optical see-through HMD conceptual diagram

AR Devices

Of these days: they both at least have a color camera and a depth camera



Depth Cameras

Color camera produces pixels with RGB values, each within 0~255.

Depth camera produces pixels with depth values.

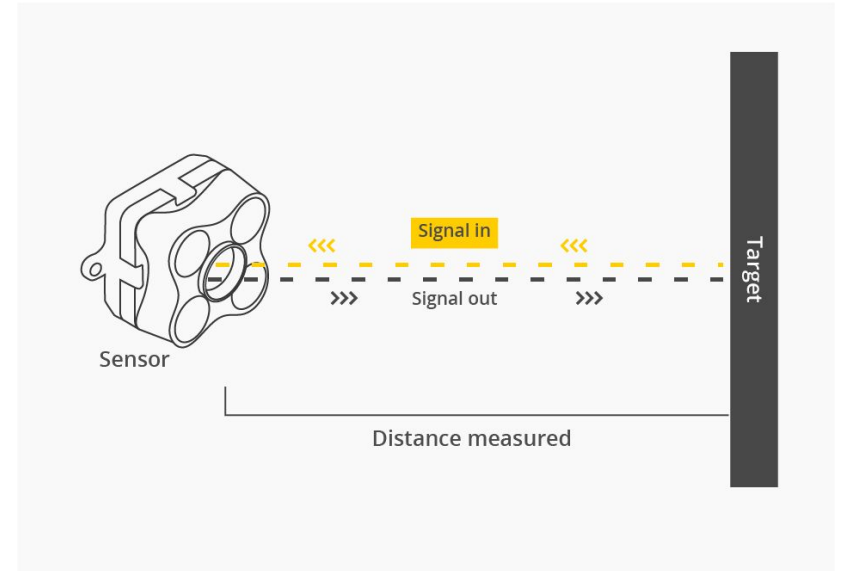


Time of flight

Shoots infrared photons and figures depth information based on it.

Distance = (Round-trip time / Speed of light) / 2

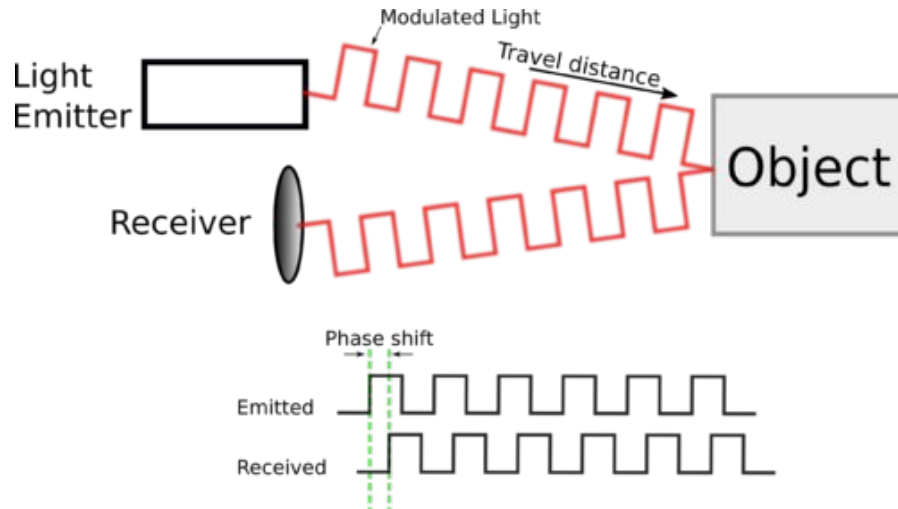
(divided by 2 since it is a round-trip)



Time of flight

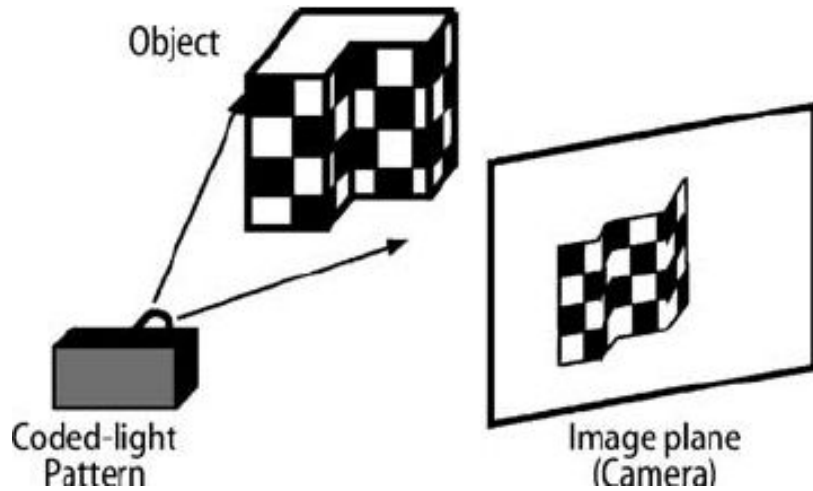
Since light is very fast, relying only on round-trip time leaves large errors.

So, there are some techniques for improvement, e.g. looking at phases.



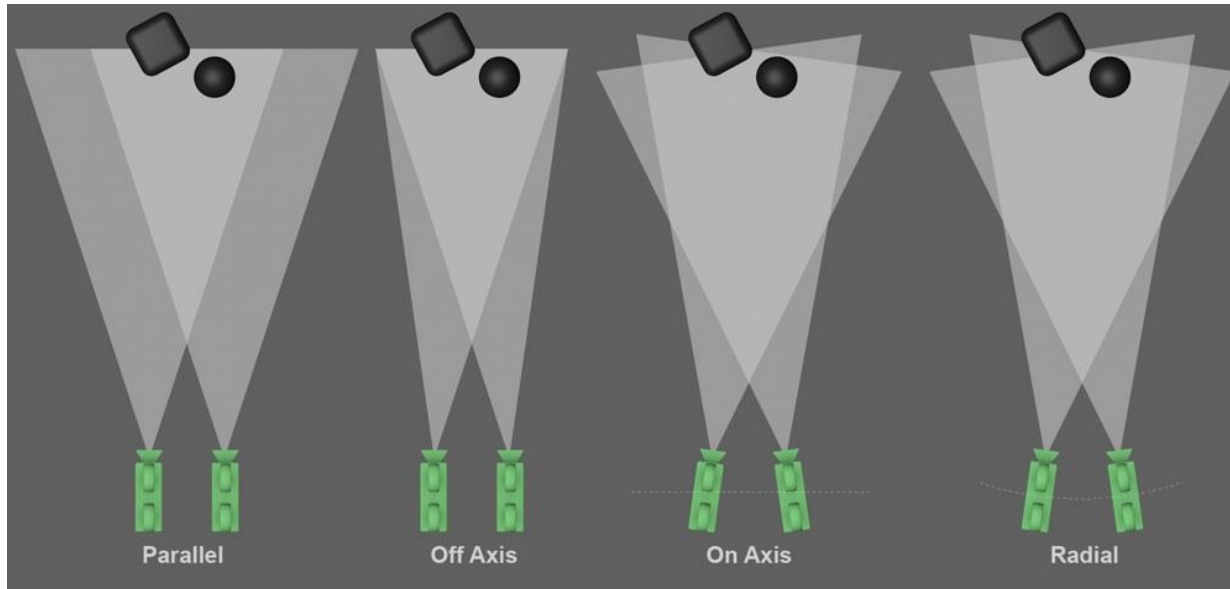
Coded Light

Emit light with a pattern that the camera can later use in depth estimation.



Stereoscopic Camera

Similar to binocular disparity people have: guessing it with the brain. Can work without a projector; therefore range cannot be limited.



Combination of Techniques

These techniques can be applied to a single device:

Stereo IR camera with light projected with code.



Combination of Techniques

Measure time of flight with each camera. Apply coded information to reduce error and cross-validate the two images from the two cameras.



Not only for Depth Cameras

Color cameras, also, are not simple devices that directly capture pixels.

Example: they may merge multiple photos into one result photo for users.

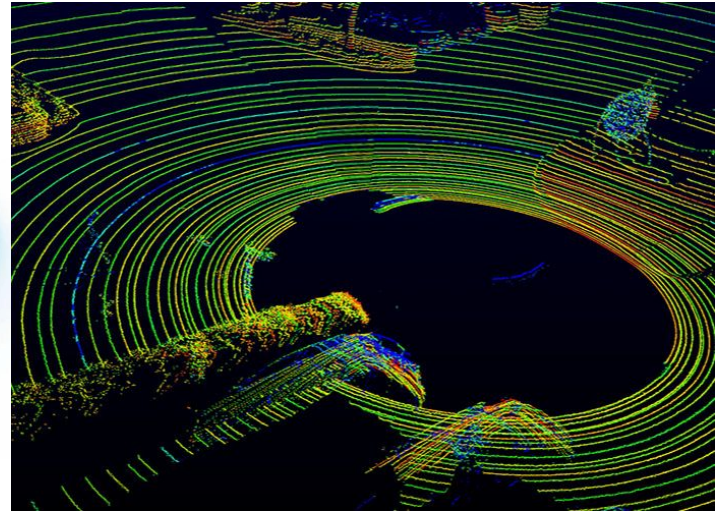


Lidar

The sensor on top of the automatic driving cars.

Rotates quickly, shooting laser and reading depth.

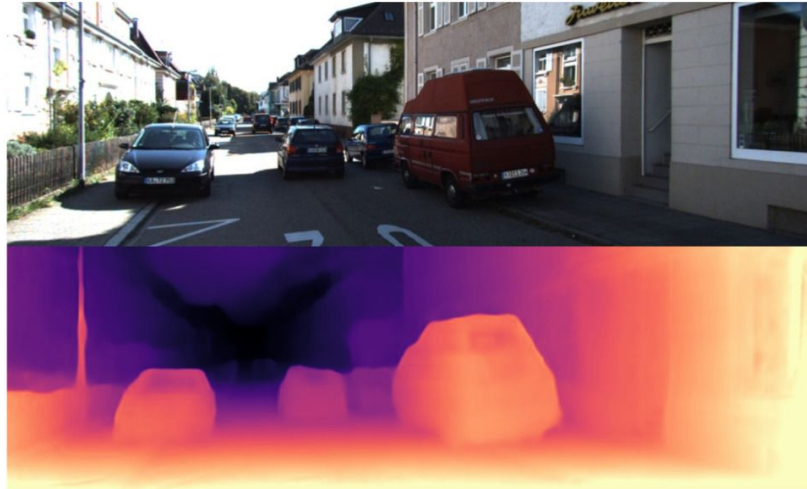
Larger range, but larger size and are expensive (not for a living room).



Single Camera Depth Estimation

Converting a color camera to a depth camera relying on statistics.

Similar to a human guessing depth with only a single eye. Relies heavily on prior experience from this planet (e.g., size of cars).



Cameras will be the Future

For example, IMU sensors

provided time series signals with enough information, simple enough for computers in the previous generation.

But with computers with high computational power and enough cameras...

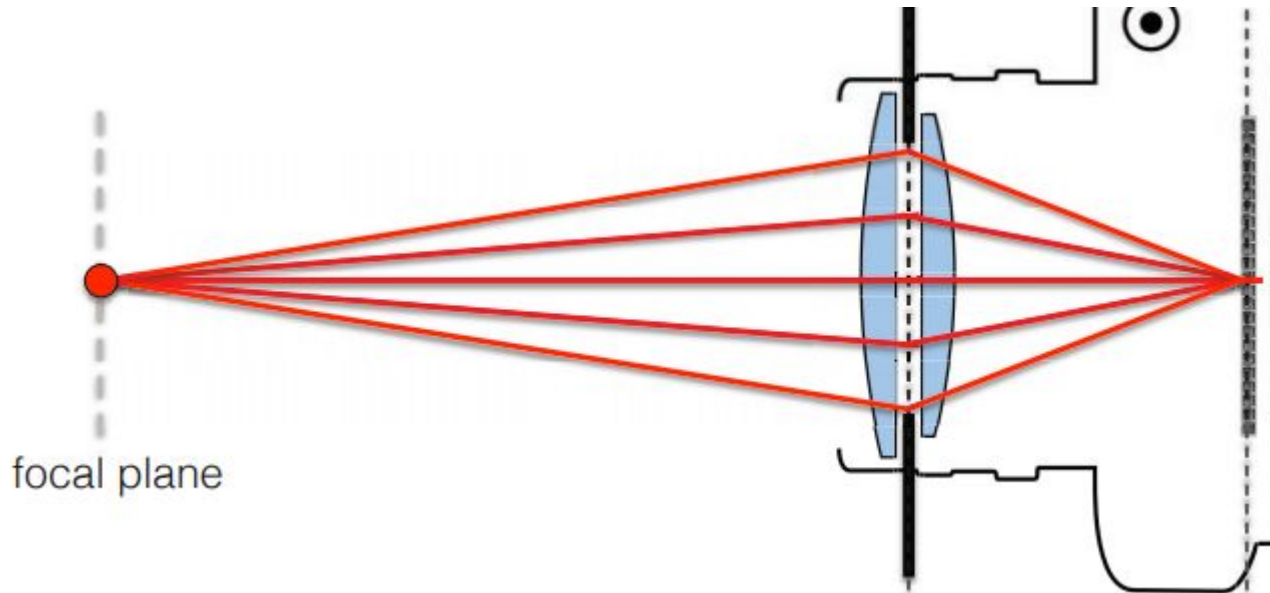
AR can be implemented without IMU sensors but only with cameras.

Light Field Cameras



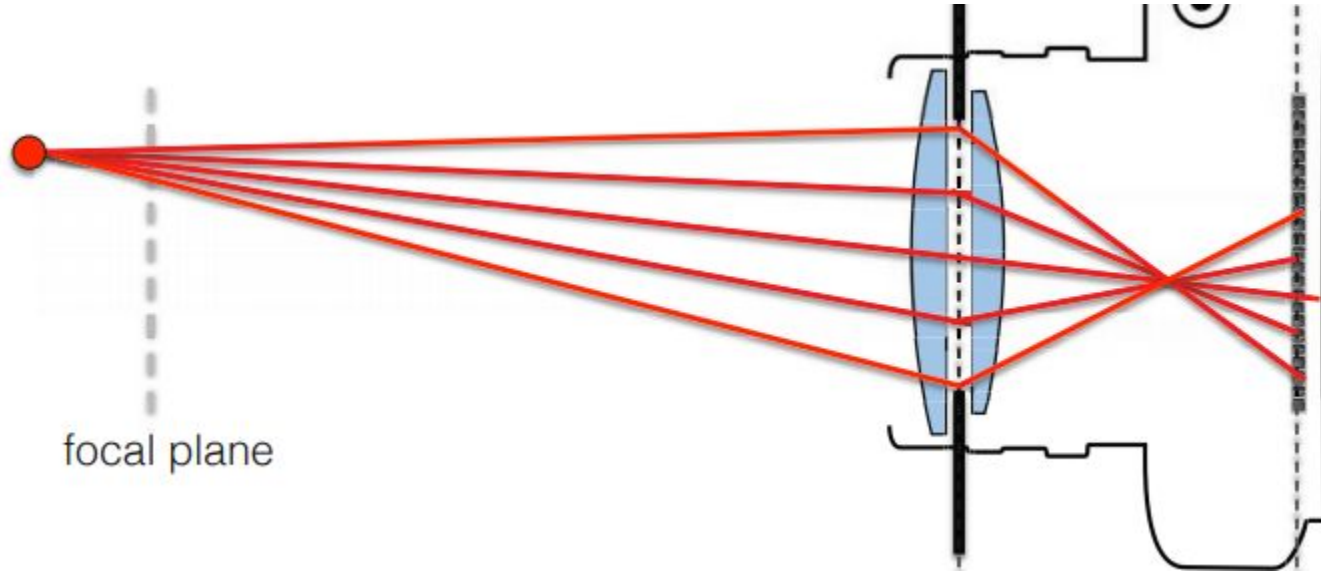
Light Field Cameras

Camera capturing color of an object at focal length with a single sensor pixel.



Light Field Cameras

Camera capturing out-of-focus object's color with the combination of directions of different sensor superpixels.



Light Field Cameras

A single photo with superpixels can produce photos of the same scene as if it was taken multiple times with different lenses, but with lower resolution...

