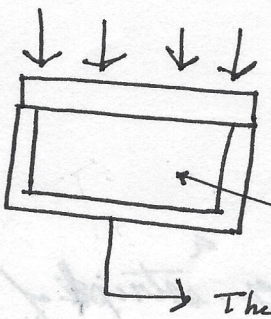
DIGITAL IMAGE Processing Lecture 3

Image acquisition and Sensing.

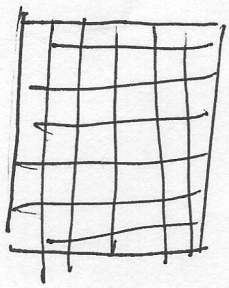
IMAGE SENSORS



* Think of a photodiode, Place a filter on top, stack into an array, then you have your pixels

Note, usually we have many such sensors in a camera.

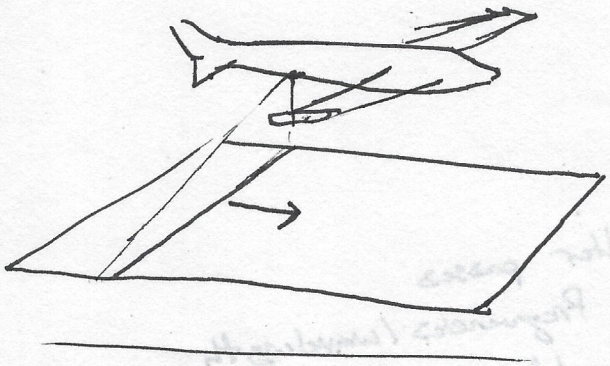
Usually, sensors are arranged in an array



It's common to also have a single strip of sensors

- common in flatbed scanners
- line of sensors going across the width of the page.
- Photo copyers
- Fax machines

(21) say we have an aircraft surveying terrain, it may be doing so with a moving stripe on the ground that is picking up responses ~~as~~ as ~~the~~ stripe moves forwards



Some deal with a CT scan, you are getting a ~~strip~~ of responses from rays ~~that~~ pass through the patient. As the patient is moved laterally through ~~the~~ ring, you acquire information ~~of the~~ whole body.
So you don't get a whole Image at once.

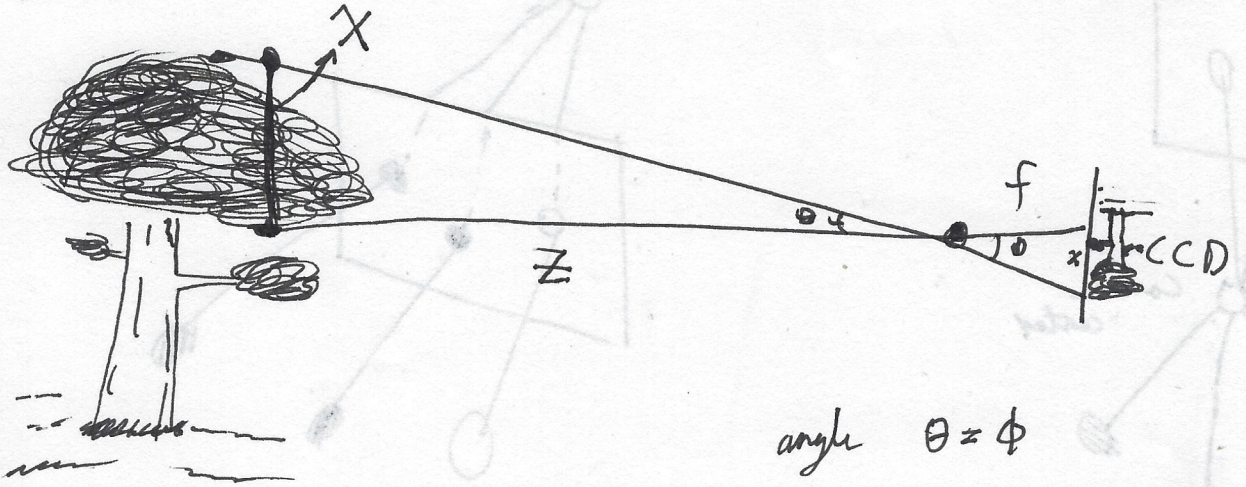
So how do we go from information from the outside world to a digital image?

CCD

the simplest model for the process of the image being formed on the sensor is known as <u>pinhole image projection</u>

→ say there is an infinitely small hole, (like the camera's aperture)

→ Rays of light pass through the pinhole and pinge on the sensor



angle $\theta = \phi$

On the sensor, we have a tiny upside down image of what we are looking at.

So if we have an object of a certain size, how big is it going to appear on the CCD, how many pixels will it take up?

Denote the ~~focal length~~ focal length, f. f is the distance from the aperture and the ccd. —It's a small number measured in the ~~mm~~ mm.

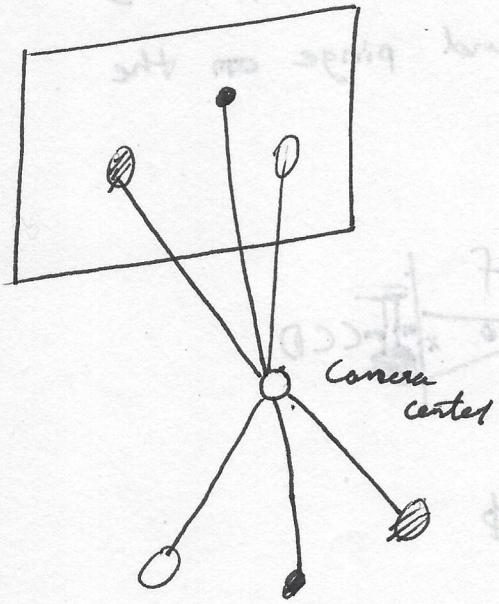
* The variable Z is not clear as what it measures, Let's assume it measures from a point on the <u>trees</u> to the <u>aperture</u>.

→ we may note the relation ship:

$$\frac{X}{Z} = \frac{x}{f} \rightarrow x = f X Z^{-1}$$

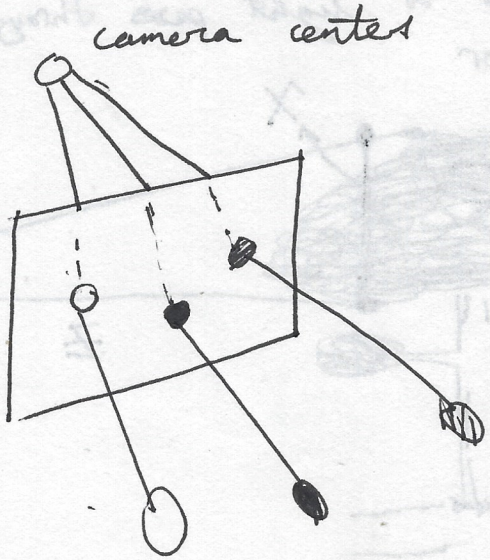
Let's denote the location of the aperture (0,0,0)

you know ~~that~~ before the plane is passed to you, the image is flipped. We see a familiar model on the left-hand-side



Scene

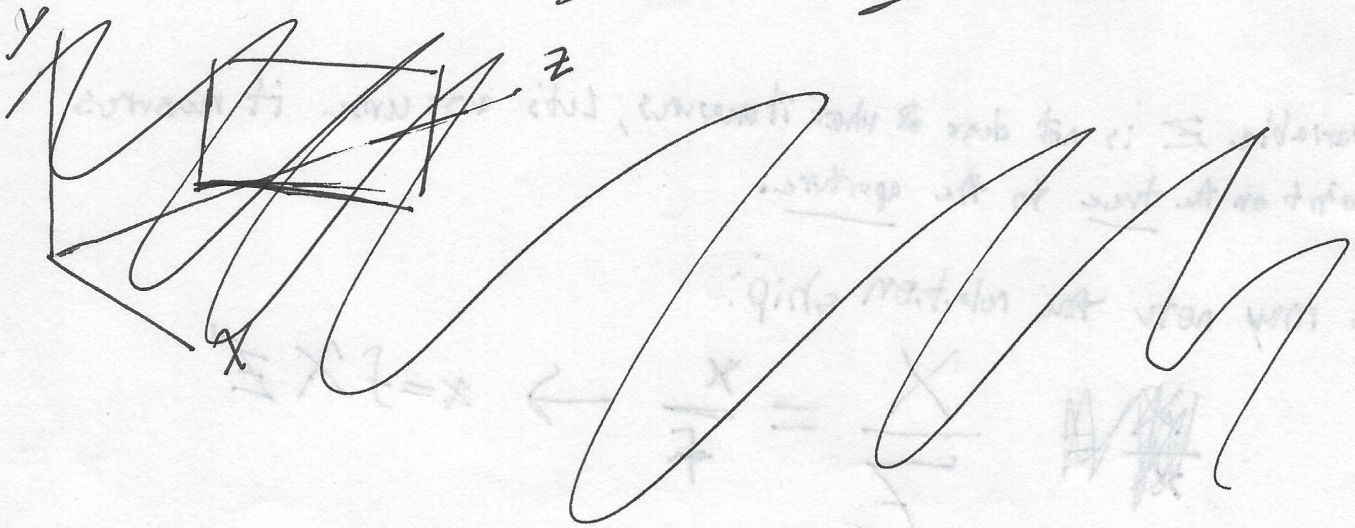
(a)



(b)

You can ~~imagine~~ imagine the image plane inbetween the world and the aperture to see things right-side-up.

Here's another way of looking at it



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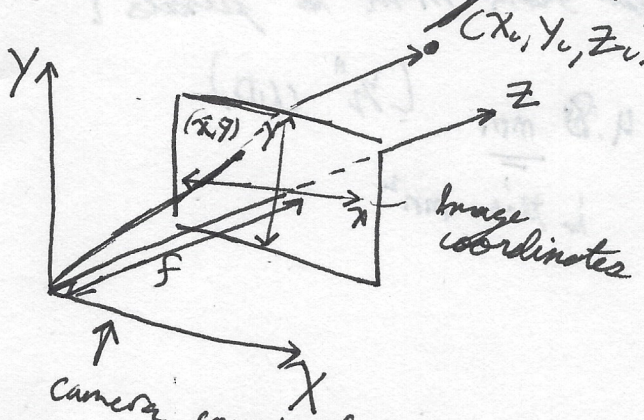
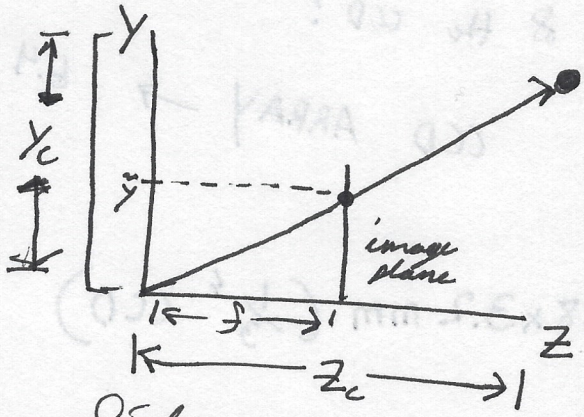


the origin is the aperture.



Side view

We have a point in world coordinates (3D)

Camera pinhole at (0,0,0)

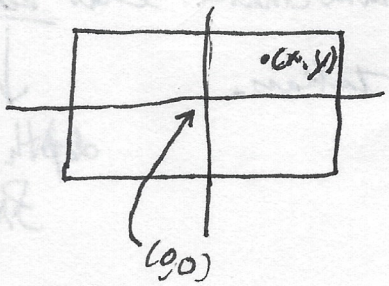
Projection of (X, Y, Z) onto image plane

is (x, y) where

$$x = f\frac{X}{Z}, \quad y = f\frac{Y}{Z}$$

Note: any point on the ray (from the tree to the CCD) will be projected onto the same point.

x and y will tell me that on the ccd array



if X, Y, Z are in m

then x, y, Z are in mm

as f is usually measured in mm

(6) to get pixels how do we get from mm to pixels?

* size & the CCD?

CCD ARRAY → 6.4 × 4.8 mm (½" CCD)

is this mm²

4.8 × 3.2 mm (⅓" CCD)

Full frame is 36 × 24 mm → 864 mm²

Note-to-self: Maybe I should get a DSLR camera before they are all gone.

Is there some google algorithm where you can refocus out on image after the fact. (After you took it)

A Photographer has ~~Depth~~ Depth of Field

Idea: take a portrait, the close object is in focus, and perhaps it's a pleasing picture if the background is somewhat out-of-focus.

→ It's hard to get this with a small sensor (CCD) and a tiny focal length, f,

→ you need a real camera to get that.

The idea is that you could hallucinate that focus after the fact that the image was already taken.

↓

depth of field

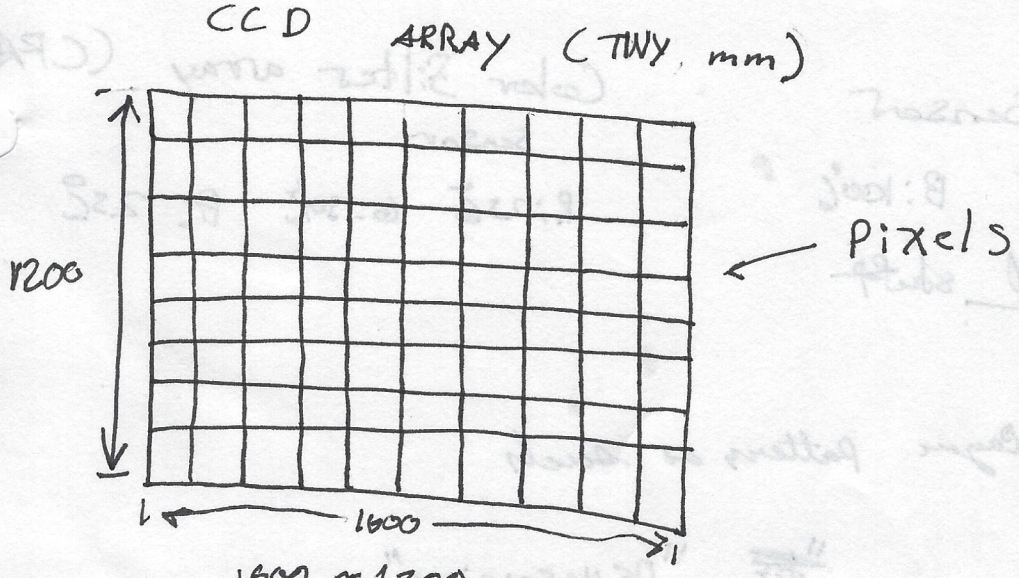
→ use an infrared camera (range image of the camera) to send infrared light off the subject to figure out how far away they are. Focus on my stuff should not be in focus & it blurs it out after the image has been acquired.

Project Idea

Computational photography

→ Coded aperture ?

Depth perception, requires two optical camera's — this is the future.



Notion of Image resolution and Mega pixels

= 1920 K Pixels ≈ "2 Mega Pixels"

Don't just worry about the number of mega Pixels, First worry about the sensor size,

Mega Pixels is not the measure of quality for an image

8

The pixels in most digital cameras are the pixel color responses

* Pixel Color responses are usually arranged in a "Bayer Pattern"

We don't get a raw reading of red, green, blue at every pixel (?) — So that it would mean every pixel would have some level of each R, G, B

every pixel in the digital camera has basically only 1 color reading → ~~other~~ either Red, Green, Blue

We have

Direct Image Sensor

R: 100% G: 100% B: 100%

High end stuff

Color filter array (CFA) sensor

R: 25% G: 50% B: 25%

→ Say we have a Bayer pattern as such

B G B G B G
G R G R G R
B G B G B G

~~DE~~ "DEMOSAICING"

To get the green at that point, we may need to average the greens nearby (4 of them). Same goes for the Blue.