6.A44 Computational Photography

Depth of Field

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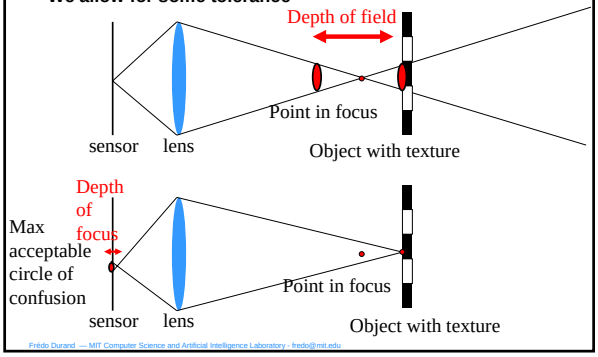
Add date: Friday

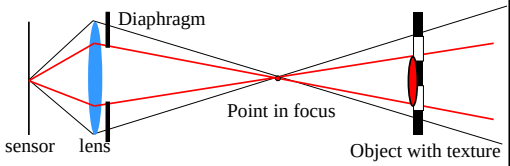
Depth of field

- **We allow for some tolerance**



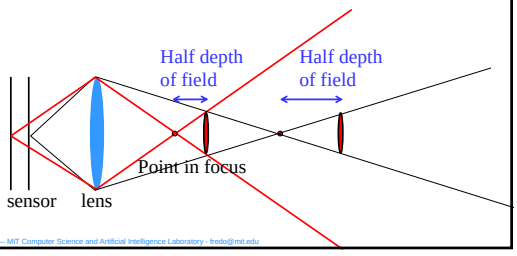
Depth of field

- **What happens when we close the aperture by two stop?**
  - Aperture diameter is divided by two
  - Depth of field is doubled



Depth of field depends on focusing distance

- **What happens when we divide focusing distance by two?**
  - Similar triangles => divided by two as well



DoF summary 1

- **Half aperture, Double DoF**
- **Double distance, double DoF**
- **Focal length?**

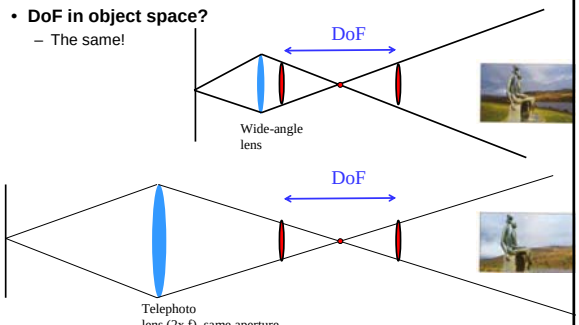
Depth of field & focal length

- **Recall that to get the same image size, we can double the focal length and the distance**
- **Recall what happens to physical aperture size when we double the focal length for the same f number?**
  - It is doubled

24mm 50mm

Depth of field & focal length

- **Same image size, same f number**
- **DoF in object space?**
  - The same!

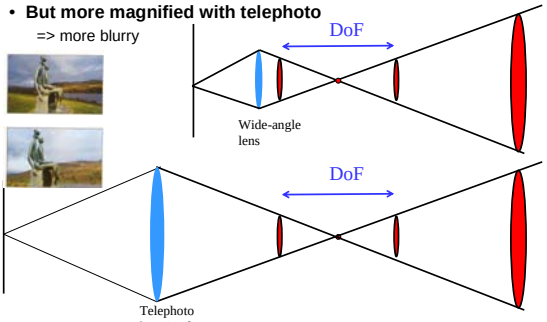


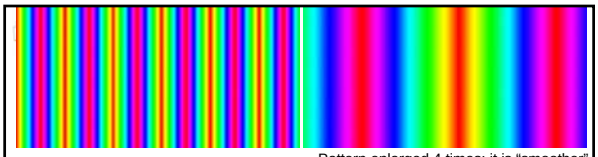
Important conclusion

- **For a given image size and a given f number, the depth of field (in object space) is the same.**
- **Might be counter intuitive.**
- **Now what happens to the background blur?**

Background blur for distant object

- **Same object-space blur**
- **But more magnified with telephoto**
  - => more blurry





Pattern enlarged 4 times: it is "smoother", looks more blurry

Important conclusion

- **For a given image size and a given f number, the depth of field (in object space) is the same.**
  - That is, the depth of acceptable sharpness is the same
- **But the background looks more blurry with telephoto**
  - Because it gets magnified
- **Notice that magnification is**
  - 1 around the object (because we change the distance)
  - 2 at infinity
  - Assignment: Guess the function!

Seeing beyond occlusion

- Photo taken through zoo bars
- Telephoto at full aperture
- The bars are so blurry that they are invisible

Crazy DoF images

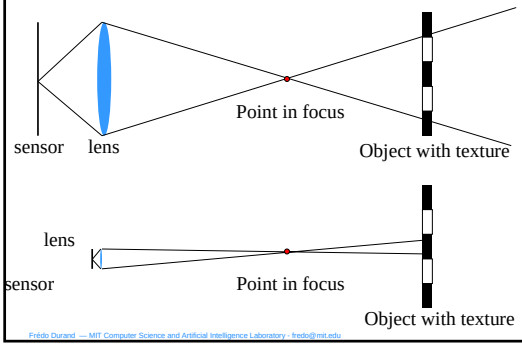
- By Matthias Zwicker
- The focus is between the two sticks

Sharp version

Really wide aperture version

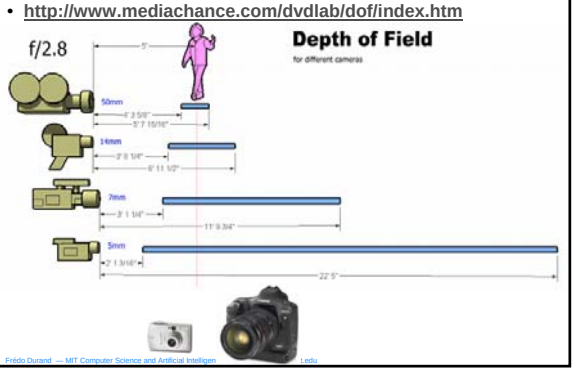
Depth of field

- It's all about the size of the lens aperture



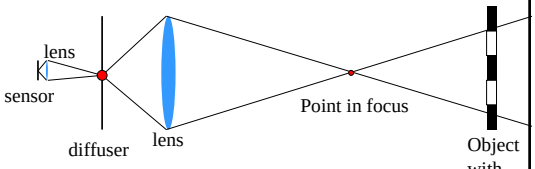
Sensor size

- http://www.mediachance.com/dvdlab/dof/index.htm



The coolest depth of field solution

- http://www.mediachance.com/dvdlab/dof/index.htm
- Use two optical systems



The coolest depth of field solution

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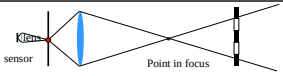
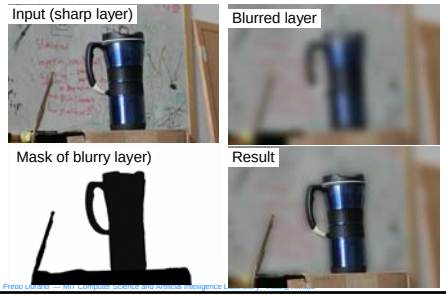


Photoshop

- **Using layers:**
- **One sharp layer, one blurry layer (using Gaussian blur)**
- **Layer mask selects focus**

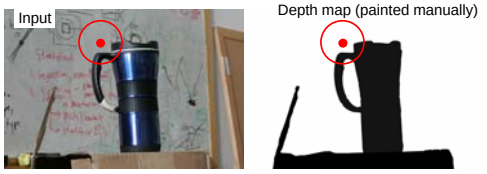


Photoshop

- **Problem: halo around edges**

Photoshop lens blur

- **Reverse-engineered algorithm: average over circle**
- **Size of circle depends on pseudo depth**
- **Discard pixels that are too much closer**

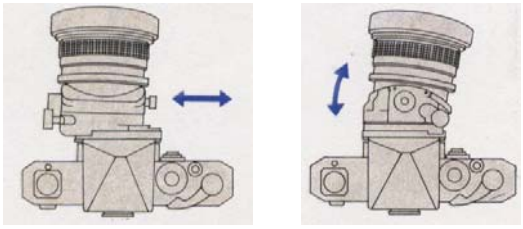


Photoshop lens blur

- **Filter>Blur>Lens blur**

Tilt-shift lens

- **Advanced control on Perspective**
  - In particular for architecture
- **Advanced control on plane of focus**
  - Does not need to be parallel to film



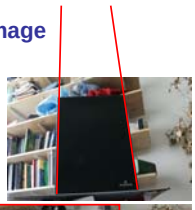
Architectural perspective

- **Problem: converging verticals**
- **Normal since we look upwards**
- **But disconcerting**

Snapshot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching

Solution: crop a wider image

- **Take a very wide angle**
- **Crop the upper part**

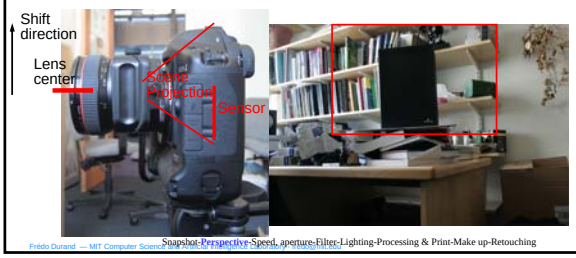


Wide-angle image
looking upward
Notice the converging verticals

Image with wider
field of view (sort of)
The viewing direction is horizontal,
the verticals are parallel.
When we crop, we get what we wanted

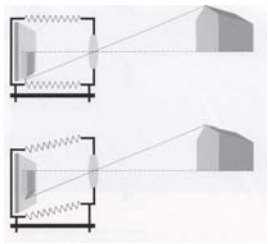
Solution: crop a wider image

- **Take a very wide angle**
- **Crop the upper part**
- **This is what shifting does**

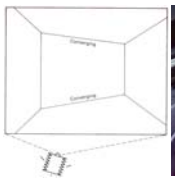


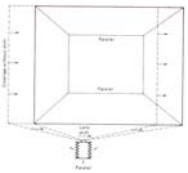
Architectural perspective

- **Solution: view-camera**
- **Lens shifted with respect to film**



Architectural perspective





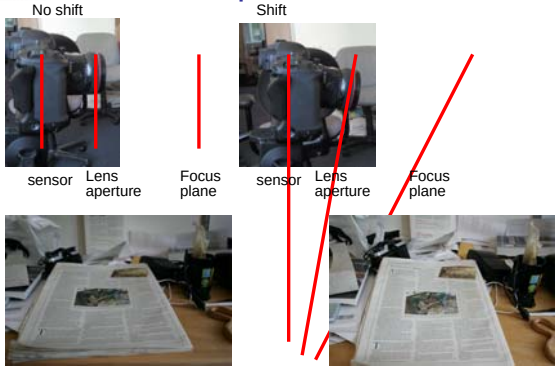
Digital perspective correction

- **Photoshop, distort**

Digital perspective correction

- **Photoshop, distort**
- **Can be done traditionally**

Shift: control plane of focus



- **Useful for landscape to get depth of field from foreground to infinity**

Soft focus

- **Everything is blurry**
- **Rays do not converge**
- **Some people like it for portrait**

With soft focus lens

Assignment

- **Guess the function (slide 12)**
- **Take a high-dynamic range picture.**
  - Get HDRShop
  - Calibrate the camera response curve (you can share the curve)
  - Use the bracketing mode on the camera to take a sequence of 3 pictures
  - Assemble a high-dynamic-range image using HDRShop