Department of Computer Science
University of Bristol

COMS30121 - Image Processing and Computer Vision

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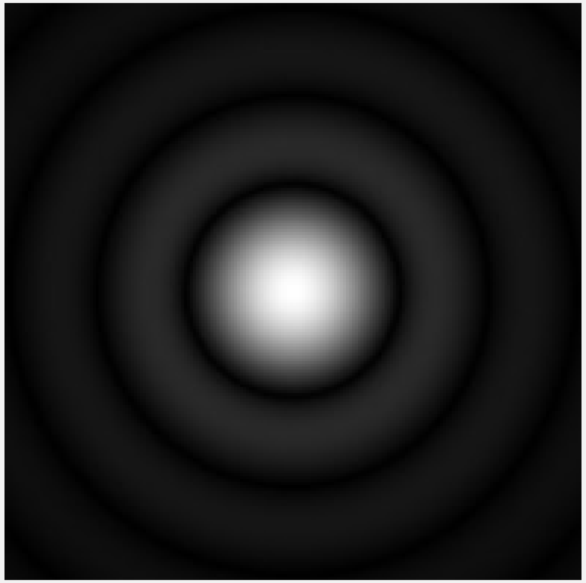

Seminar Week 02

Key Points, Feedback and Comments

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Challenge 1

- **Building a Camera Obscura.** Many solutions are possible. One option would be to build a large dark chamber using the black sheets; put a tiny hole in the cardboard and use it as an opening of the chamber. Place a cardboard wall opposite the opening (distance is focal length) to form an image plane. Go inside the chamber and use the pencil and paper (placed on the image plane) to sketch the image projected.
- **Fading Projection of Pinhole Cameras.** The major reason is the fact that the material with the pinhole (e.g. cardboard) has some thickness. Thus, the pinhole actually represents a tubular opening and the actual size of the visible opening reduces towards the periphery of the projected image, reducing brightness.
- **Effect of Pinhole Size.** A larger pinhole produces a brighter image, a smaller pinhole produces a sharper image.
- **Point Spread Function.** See lecture slides 5 and 6 of lecture 2 for details on Dirac Impulse and PSF.
- **Effect of Point Spread Function.** The created image of a pinhole camera (response) can be interpreted as the result of convolving the incoming light (input image) with the point spread function (kernel). The point spread function of a pinhole camera shows a ring structure, thus there will be some interference effects in the resulting response image.

Challenge 2

- **Aliasing.** The sent image was sampled at too low a frequency (below the Shannon-Nyquist limit) and, thus, it shows artefacts not present in the original image (concentric rings at top, bottom, left and right). This is known as aliasing. Classic, similar effects can be seen when a striped shirt is undersampled and appears with aliasing on TV.
- **Shannon Nyquist Theorem.** The theorem states that one has to sample above twice the maximum frequency present in the signal to reconstruct the signal accurately without aliasing.
- **Ways to Avoid Aliasing.** One can either increase the rate of sampling (higher resolution camera) or lower the maximum frequency in the incoming signal. The latter can be achieved by, for instance, a special lense that blurs the incoming image slightly or by taking a different shot (close to the centre of Newton's rings) where the object does not contain high frequencies.
- **Shannon Nyquist Limit.** The Shannon Nyquist Theorem discusses the ‚maximum frequency present' in the signal. Note that this may not be the maximum frequency you are interested to capture – any present frequency in the signal needs to be considered to avoid aliasing.

Challenge 3

- **Wheels Turning Backwards.** The camera takes a sample of the world every 1/25th of a second. If the car wheels have turned from frame to frame enough to having revolved just under a full revolution, we are presented with consecutive frames in which the wheel seems to turn slowly backwards.
- **Ways to Avoid Aliasing.** One can, for instance, either increase the rate of sampling (higher frame rate camera) or get rid of the patterns on the wheel altogether.
- **Benham's Disc.** Fast revolution of the second wheel causes the human visual system to reconstruct and interpret some colour in the image sequence which clearly does not contain any. This phenomenon is not fully understood.
- **Assessing Performance.** The effect of Benham's Disc serves as an example that our human visual system cannot be relied upon to judge properties of images objectively. Thus, we need quantitative methods to evaluate the performance of computer vision algorithms.