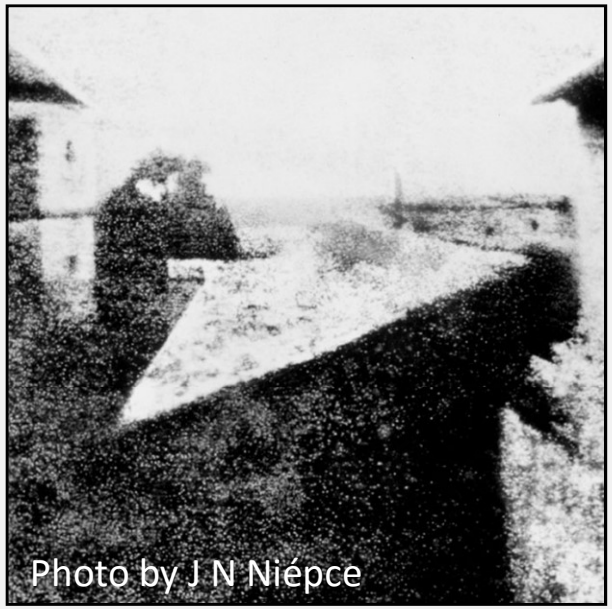
Department of Computer Science
University of Bristol

COMS30121 - Image Processing and Computer Vision

www.cs.bris.ac.uk/Teaching/Resources/COMS30121



Seminar Week 02

Pinhole Camera and Aliasing

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Challenge 1: Image Acquisition – Fundamentals

You are stranded on an island. You only have some black sheets, cardboard, a mirror, a semi-transparent screen, tape, a pencil, thin paper and some basic work tools available. You decide to build a pinhole camera to help you draw a more accurate view of the island so you can send this image in a bottle to tell the world where you are and to get help.

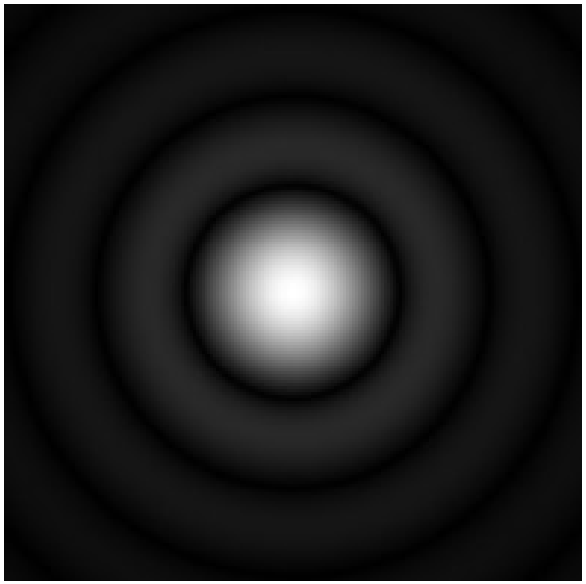
a) Sketch how you would build your device. Comment on the properties of the image produced (e.g. orientation, size).

b) Why does the image appear brighter in the centre of the projection and fades out towards the periphery?

c) What effect does a change of the size of the pinhole have on the image produced?

d) What is meant by the point spread function (PSF) and how does it relate to the Dirac Impulse?

e) The image on the right depicts the actual point spread function of some pinhole camera.
Discuss the properties of the function depicted and the implications for imaging.



Challenge 2: Image Acquisition – Spatial Aliasing

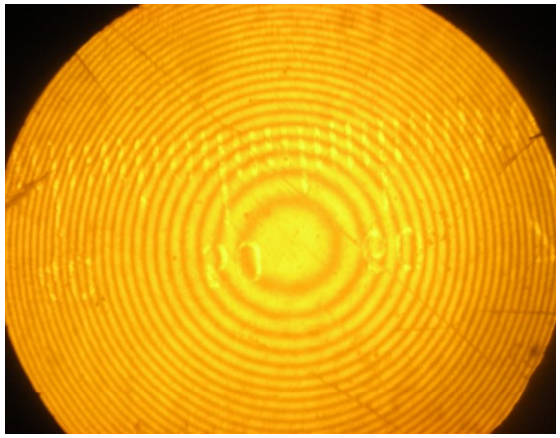
You are working at a scientific imaging department and have just seen a manifestation of Newton's rings under a microscope (left figure). Without considering imaging details, you take a small image of the phenomenon (with a cheap webcam) and send it to a friend. In the reply email he mentions that he has never seen Newton's rings occurring multiple times in such a structured way (right figure) and wonders if you are onto some new physics here...

a) What has happened?

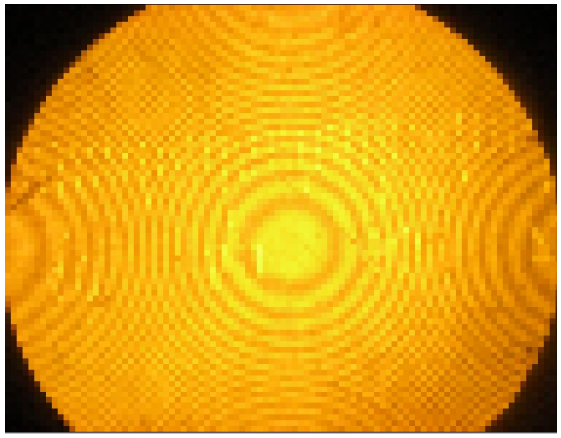
b) Discuss what the Nyquist theorem states and how it relates to the problem at hand.

c) Come up with 3 different ways to address the imaging problem by modifying the camera setup?

d) In which case is it not sufficient to sample an image at twice the max. spatial frequency you want to capture accurately? Relate your answer to the images at hand.



Under the microscope...



The image you took...

Challenge 3: Image Acquisition – Temporal Aliasing

You are working at a movie production company and have just shot an advert for a new car model using HD and 25fps. However, during postproduction the client rings up and complains that in some video scenes some car wheels (structured as depicted in left figure) turn backwards whilst the car drives forwards. In another scene the car wheel design provided by the client (right figure) – he claims - was changed and now appears coloured. You confirm with the crew that no wheels turned backwards and no colour was added...

a) What has happened in each of the scenarios?

b) Again, how does the backwards-turning problem relate to the Shannon-Nyquist theorem?

c) Come up with two different ways to address the backwards-turning problem by modifying the movie script or camera specs?

d) Given the above problems, discuss the importance of methods independent of our human visual system for judging the performance/quality of computer vision systems.