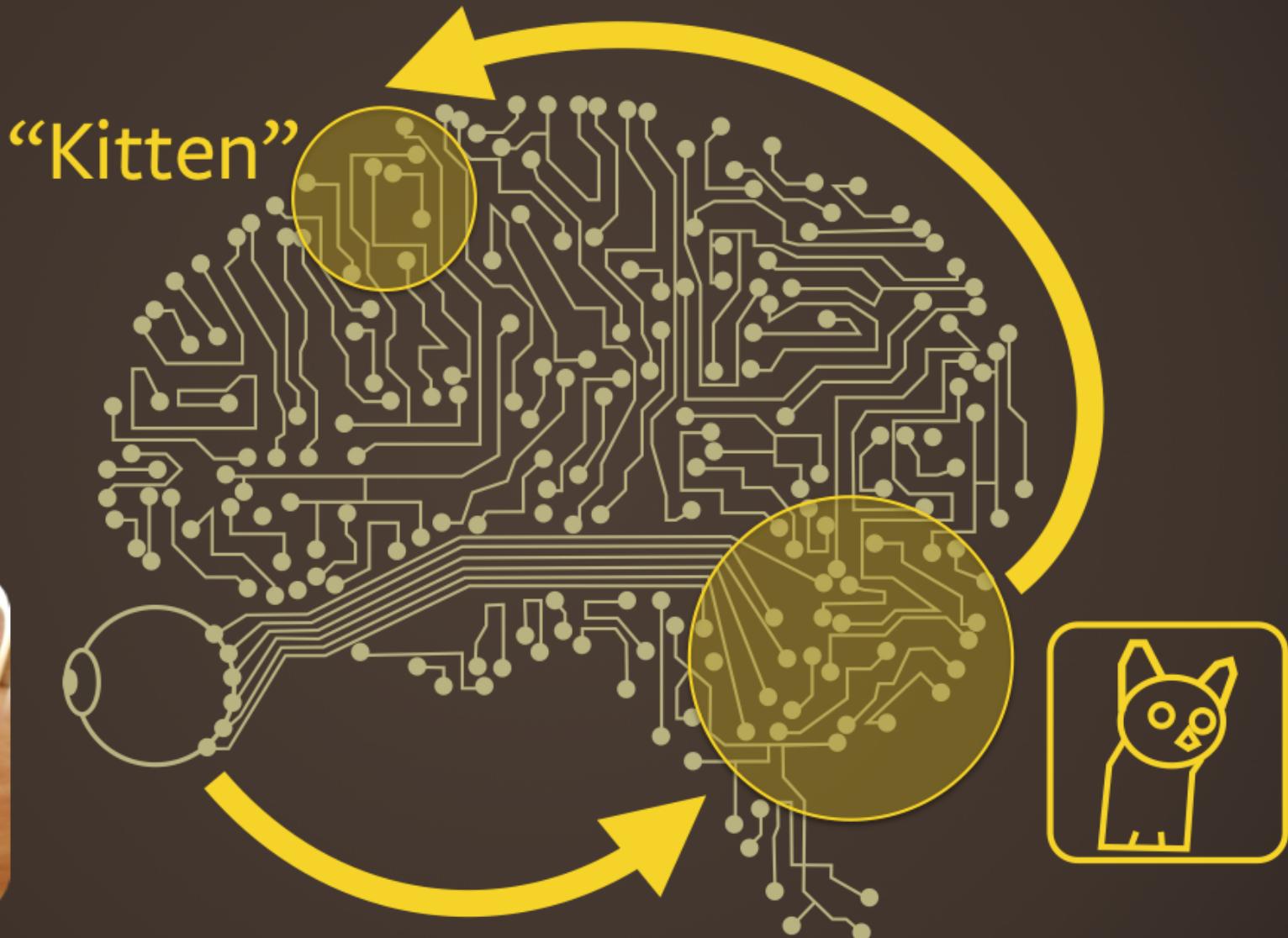


# Introduction to Computer Vision

COMP3204 & COMP6223 2017/18

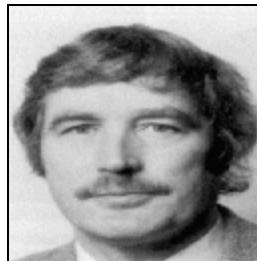


Mark Nixon and **Jonathon Hare**

# Processing Scheme

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Acquire image



Low-level  
processing



High-level  
processing



# What can image analysis achieve?

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WHEN A USER TAKES A PHOTO,  
THE APP SHOULD CHECK WHETHER  
THEY'RE IN A NATIONAL PARK...

SURE, EASY GIS LOOKUP.  
GIMME A FEW HOURS.

... AND CHECK WHETHER  
THE PHOTO IS OF A BIRD.

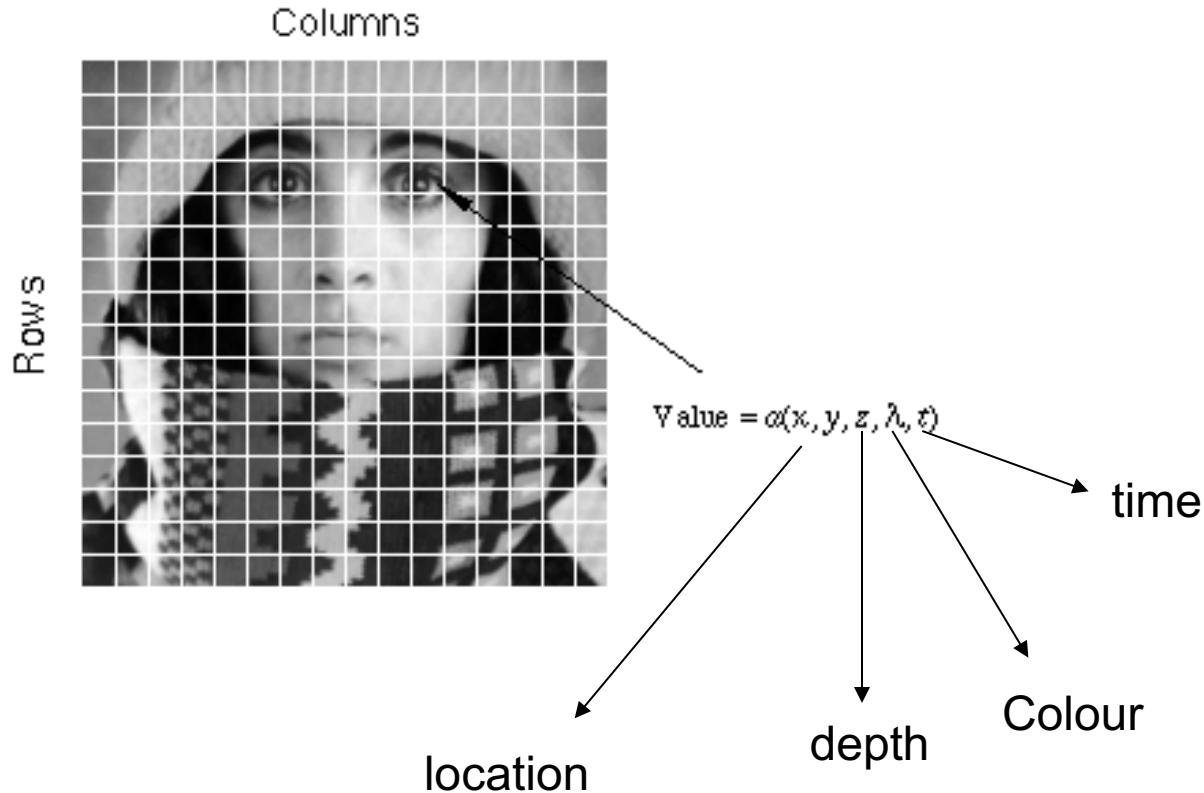
I'LL NEED A RESEARCH  
TEAM AND FIVE YEARS.



IN CS, IT CAN BE HARD TO EXPLAIN  
THE DIFFERENCE BETWEEN THE EASY  
AND THE VIRTUALLY IMPOSSIBLE.

# Images consist of picture elements known as “pixels”

---

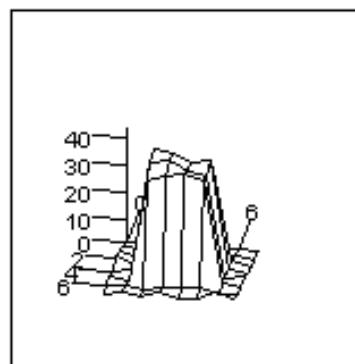


# 2D Images are therefore matrices of numbers

---



Grey level image



3D view

pic =

$$\begin{bmatrix} 1 & 2 & 3 & 4 & 1 & 1 & 2 & 1 \\ 2 & 2 & 3 & 2 & 1 & 2 & 2 & 1 \\ 3 & 1 & 38 & 39 & 37 & 36 & 3 & 1 \\ 4 & 1 & 45 & 44 & 41 & 42 & 2 & 1 \\ 1 & 2 & 43 & 44 & 40 & 39 & 1 & 3 \\ 2 & 1 & 39 & 41 & 42 & 40 & 2 & 1 \\ 1 & 2 & 1 & 2 & 2 & 3 & 1 & 1 \\ 1 & 2 & 1 & 3 & 1 & 1 & 4 & 2 \end{bmatrix}$$

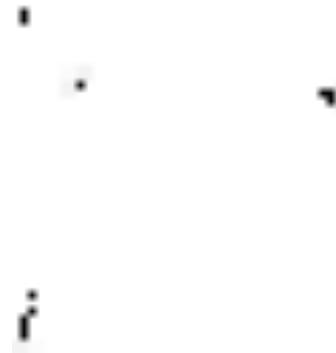
Pixel

Corresponding Matrix

# Point Operations

---

Recalculate point values



Modify brightness

Find Intensity

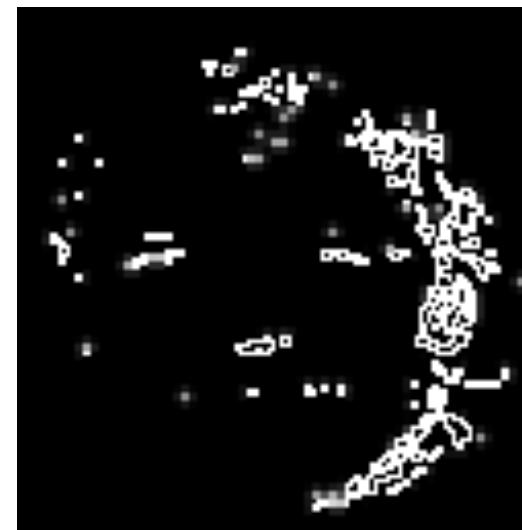
# Group Operations

---

Process neighborhoods



Image Filtering



Edge Detection

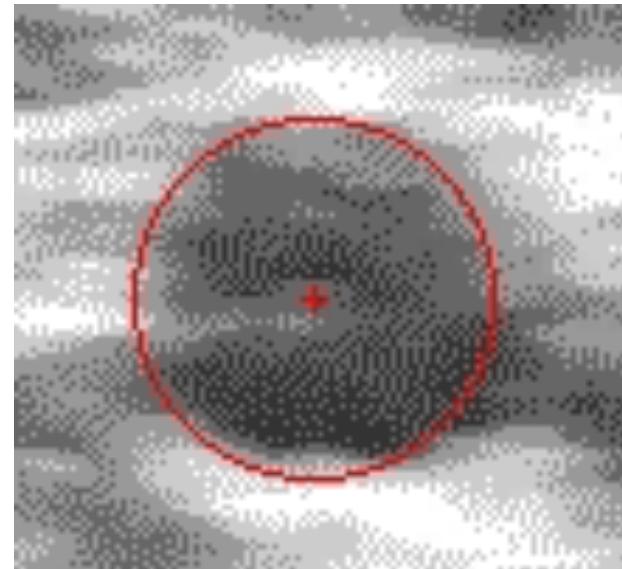
# Feature Extraction

---

Finds **shapes**



**Roads** in remotely-sensed image



**Artery** in ultrasound image

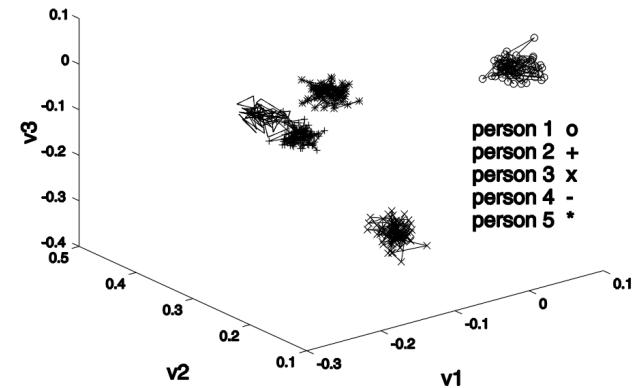
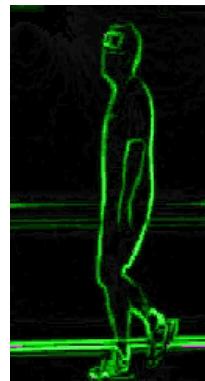
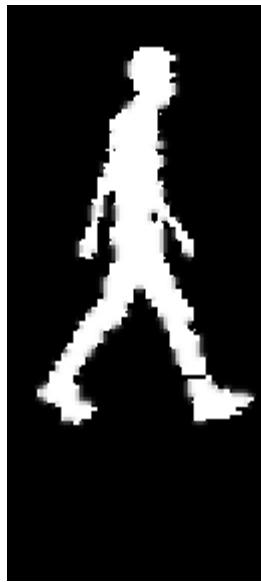
# Applications of Image Processing/Vision

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- ★ Image Coding (MPEG/JPEG)
- ★ Product Inspection
- ★ Robotics
- ★ Modern Cameras
- ★ Medical imaging
- ★ Demography (applied politics?)
- ★ Biometrics (recognising people)

# Statistical Gait Recognition

Recognising people from the motion of the **whole body**



Silhouette Flow Edges Symmetry Feature Space



# Gait Recognition

- natural walking (well....)



# Ear biometrics

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- Person identification from ear image
- Uniqueness: used in forensics
- Unique advantage: age invariant
- Unique disadvantage: hair!
- Much smaller field than gait recognition



BBC1, 2005

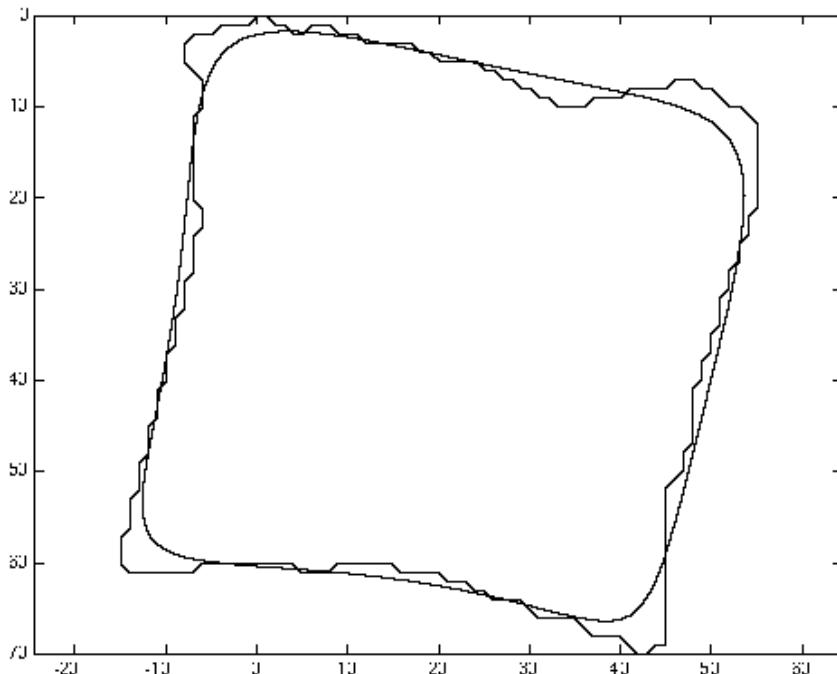
# Digital Videofluoroscopic Imaging



Zheng, Nixon and Allen,  
*IEEE TMI 2003*

# High Level Feature Extraction

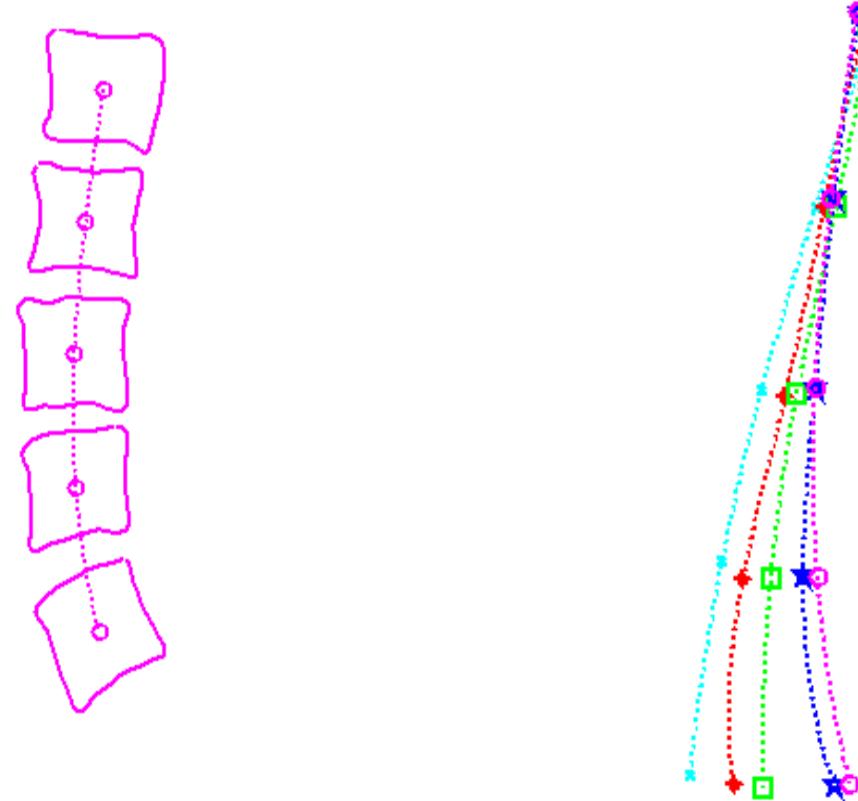
---



Zheng, Nixon and Allen,  
*IEEE TMI 2003*

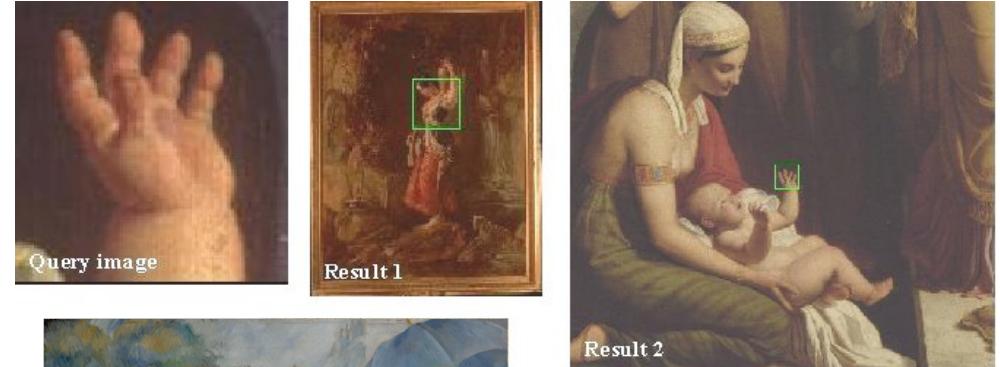
# Animated Extraction

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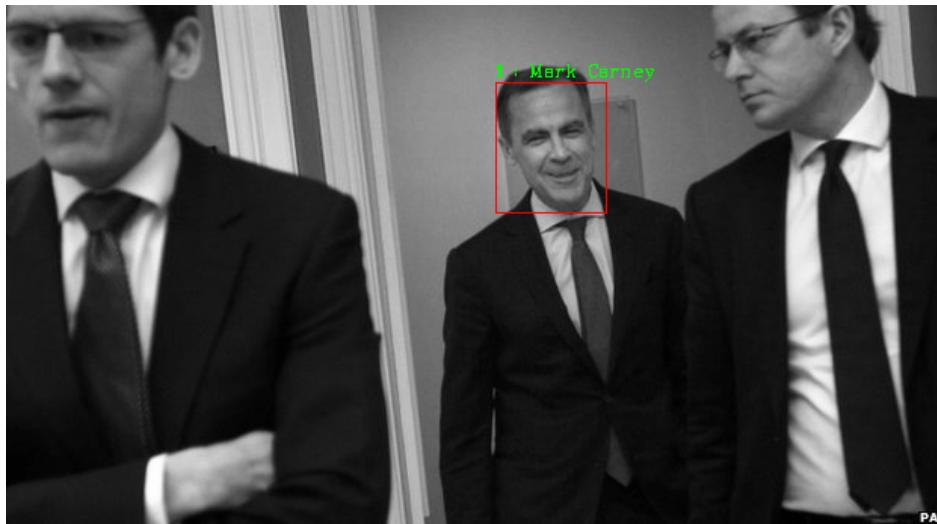


Zheng, Nixon and Allen,  
*IEEE TMI 2003*

# Content-based Retrieval and Image Matching



# Higher Level Visual Cognition

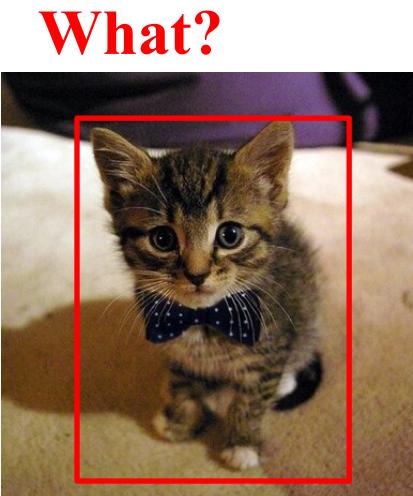


Who?



Where?

Why?



# Vision and Image Processing Support

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- WWW homepages
  - <http://comp3204.ecs.soton.ac.uk> (for both 3204 & 6223)
- Lecture support materials
- Links
- Notes
- Tutorials (on demand)
- Book

# Lecture Support (Mark)

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- ❑ Slides available online
- ❑ Worksheets
  - ❑ Mathcad
  - ❑ Used in lectures
  - ❑ Free download viewer
  - ❑ Used for independent study
  - ❑ Some Matlab, but incomplete
- ❑ Handouts\*

# Lecture Support (Jon)

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- ❑ Interactive slides with many demos  
(often using a webcam to capture images)
  - ❑ Available for you to download and run
  - ❑ Source code on github
  - ❑ (more info when we get to my lectures)
- ❑ Handouts\*

# Recommended Textbook

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<http://www.ecs.soton.ac.uk/~msn/book>



## CONTENTS

- 1. Introduction**
- 2. Images, sampling and frequency domain processing**
- 3. Basic image processing operations**
- 4. Low-level feature extraction (including edge detection)**
- 5. Feature extraction by shape matching**
- 6. Flexible shape extraction (snakes and other techniques)**
- 7. Object description**
- 8. Introduction to texture description, segmentation and classification**
- 9. Moving Object Extraction and Description**
- 10. Appendices**

**1<sup>st</sup> Edition 2002; 2<sup>nd</sup> Edition 2008 in Library**

**3<sup>rd</sup> Edition 2012 (Current price ~ £47 Amazon)**

# Assessment

- Mixture of coursework and final exam
- COMP3204: 60% exam; 40% coursework
- COMP6223: 50% exam; 50% coursework
- (exam questions are the same!)

# Coursework

- Three courseworks
  - 2 individual
  - 1 in pairs (competition format)
  - Much requested feature!
  - Designed to support learning
    - Has worked really well since introduced 3 years ago
- **Different coursework assignments for COMP3204 and COMP6223 students**

- COMP3204:
  - No 1: **Set today!** handin wk 9; fb wk 11
  - No 2: Set wk 3; handin wk 7; fb wk 10
  - No 3: Set wk 8; handin wk 11; fb wk 12 (In pairs)
- COMP6223:
  - No 1: Set wk 3; handin wk 7; fb by wk 10
  - No 2: Set wk 4; handin wk 9; fb by wk 11
  - No 3: Set wk 8; handin wk 11; fb wk 12 (In pairs)

# Finally

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✓ Enjoy!

- Mark Nixon
  - [msn@ecs.soton.ac.uk](mailto:msn@ecs.soton.ac.uk)
  - Office: 1/2021
- Jonathon Hare
  - [jsh2@ecs.soton.ac.uk](mailto:jsh2@ecs.soton.ac.uk)
  - Office: 1/2003

# Lecture Timetable

- No more lectures this week (e.g. on Friday)
- Mark will start next Tuesday for 3 weeks [9 lectures]
- I'll then take over for 4 weeks [plus a couple of extra lectures in later weeks]
- We'll run revision lectures after xmas