

## Engineering Tripos Part IIB, 4F12: Computer Vision, 2020-21

### Module Leader

[Dr I Budvytis](#) [1]

### Lecturers

[Prof R Cipolla, Dr I Budvytis](#) [2]

### Timing and Structure

Michaelmas term. 16 lectures (including 3 examples classes). Assessment: 100% exam

### Aims

The aims of the course are to:

- introduce the principles, models and applications of computer vision.
- cover image structure, projection, stereo vision, structure from motion and object detection and recognition.
- give case studies of industrial (robotic) applications of computer vision, including visual navigation for autonomous robots, robot hand-eye coordination and novel man-machine interfaces.

### Objectives

As specific objectives, by the end of the course students should be able to:

- design feature detectors to detect, localise and track image features.
- model perspective image formation and calibrate single and multiple camera systems.
- recover 3D position and shape information from arbitrary viewpoints;
- appreciate the problems in finding corresponding features in different viewpoints.
- analyse visual motion to recover scene structure and viewer motion, and understand how this information can be used in navigation;
- understand how simple object recognition systems can be designed so that they are independent of lighting and camera viewpoint.
- appreciate the commercial and industrial potential of computer vision but understand the limitations of current methods.

### Content

- **Introduction** (1L)  
Computer vision: what is it, why study it and how? The eye and the camera, vision as an information processing task. A geometrical framework for vision. 3D interpretation of 2D images. Applications.
- **Image structure** (3L)  
Image intensities and structure: edges, corners and blobs. Edge detection, the aperture problem. Corner and blob detection. Contour extraction using B-spline snakes. Texture. Feature descriptors and matching.
- **Projection** (3L)

Orthographic projection. Planar perspective projection. Vanishing points and lines. Projection matrix, homogeneous coordinates. Camera calibration, recovery of world position. Weak perspective and the affine camera. Projective invariants.

- **Stereo vision and Structure from Motion** (3L)  
Epipolar geometry and the essential matrix. Recovery of depth. Uncalibrated cameras and the fundamental matrix. The correspondence problem. Structure from motion. 3D shape from multiple view stereo.
- **Object detection and recognition** (3L)  
*Basic architectures for deep learning in computer vision. Object detection, classification and semantic segmentation. Object recognition, feature embedding and metric learning. Reconstruction, localisation and structured deep learning.*
- **Example classes** (3L)  
*Discussion of examples papers and past examination papers.*

## Booklists

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

## Examination Guidelines

Please refer to [Form & conduct of the examinations](#) [3].

## UK-SPEC

The [UK Standard for Professional Engineering Competence \(UK-SPEC\)](#) [4] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the '[Accreditation of Higher Education Programmes](#)' (AHEP) document [5] which sets out the standard for degree accreditation.

The [Output Standards Matrices](#) [6] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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## Links

- [1] <mailto:ib255@cam.ac.uk>
- [2] <mailto:rc10001@cam.ac.uk>, [ib255@cam.ac.uk](mailto:ib255@cam.ac.uk)
- [3] <http://teaching.eng.cam.ac.uk/content/form-conduct-examinations>
- [4] <http://www.engc.org.uk/ukspec.aspx>
- [5] <http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/>
- [6] <http://teaching.eng.cam.ac.uk/content/output-standards-matrices>