Maths Methods, Algorithms and Implementation
1998-99

S R Arridge, B F Buxton and V Hardman

Advanced MSc in:
Vision, Imaging & Virtual Environments,
Research Masters in:
Computer Vision, Image Processing, Graphics and Simulation

Part I: Maths Methods and Algorithms (15 hours) S R Arridge

See syllabus prepared by S R Arridge.

Part II: Algorithms and Implementation (15 hours) B F Buxton and V Hardman

Week	Begins	#	Lecturer	Topics
8	15/11	16	VH	**Compression algorithms**: types of digital signal processing operations needed in compression, understanding of compression in terms of information theory.
		17	VH	**Compression algorithms**: information theory of compression algorithms.
		18	VH	**Compression algorithms:** effects of finite length arithmetic.
9	22/11	19	VH	**Real-time systems software**: pipeline of components, example: audio device drivers, compression of a block of audio; writing real-time software for a multi-tasking operating system.
		20	VH	**Audio codec example:** simplified ADPCM codec, main loop of codec, quantisation and scaling operations, step-size adaptation algorithm, predictor (linear transversal filter).
		21	BFB	**Analogue and digital video:** camera model, digital acquisition and digital video, data rates, outline of computing requirements.
10	29/11	22	BFB	**Algorithm requirements**: algorithm characterisation and complexity, examples: image smoothing, subsampling, and image pyramids.
		23	BFB	**Low-level image processing**: FIR filters, separable convolutions, degenerate kernels, examples: Gaussian smoothing, differentiation; repeated convolution.
		24	BFB	**Linear operations**: introduction to the z-transform, response function, lumped systems, recursive filters, IIR filters, filter design, small generating kernels.
11	6/12	25	BFB	**Search and tracking algorithms**: detection algorithms, thresholding, statistical tests, object location, template matching, search strategies, tracking, the predict-measure-update cycle.
		26	BFB	**Real-time processing**: characteristics of a real-time computer system, hard and soft real time, error recovery, examples: virtual reality system, video replacement, tracking systems.
		27	BFB	**Processors**: range of hardware and processor types: CISC, RISC, DSPs, VLSI, ASICs, and FPGAs, and their main characteristics.
12	13/12	28	BFB	**Multiprocessor systems**: pipeline and parallel systems, throughput and latency, balancing, fault-tolerance, pipeline video-stream processing.
		29	BFB	**Parallel systems**: shared and distributed memory system architectures, taxonomy of parallel systems, processor farms, parallel pipelines and pipelines of processor farms.
		30	BFB	**Application case study**: automatic OCR letter address reading system (Downton), real-time requirements, trade-offs, constraints and solutions.

Note:

1. VIVE MSc: All of parts I & II are examinable.
2. CVIPGS MRes: The course is based on part I only. Examination questions will only be set on the content of part I above, and assessed courseworks will similarly apply to part I only.
3. Courseworks 1,2 and 3 are based on topics in part I for both the VIVE MSc and the CVIPGS MRes. Courseworks 2 and 3 contributes 20% towards part I of the course in both programmes.
4. Courseworks 4 and 5 are for the VIVE MSc only and similarly contribute 20% towards part II of the course.

Courseworks and Practicals (~ 20 hours)

For courseworks 1-3 see S R Arridge's syllabus notes

#	Week Set	Week due	Responsible	Topic
4	9 22/11	11 10/12	VH	**Analysis of a simplified ADPCM codec:** analysis of an existing main codec: main loop of codec, quantisation and scaling operations, step-size adaptation algorithm, predictor (linear transversal filter).
5	10 6/12	13 10/1	BFB	**Implementation and timing of low-level operations:** complexity estimates for FIR and recursive filters, design of a simple pipeline and estimation of throughput and latency (exercise), followed by emulation and measurement of throughput and latency (practical).

Note:

1. Courseworks 3 and 4 are assessed and contribute 20% towards part II of the course.

Bernard Buxton
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