



# packet video

*Modeling and Signal Processing*

Naohisa Ohta

# Contents

Preface	ix
Acknowledgments	xi
Chapter 1 Introduction	1
1.1 Visual Media and Communication	1
1.2 Digitalization of Media and Communications	2
1.2.1 Visual Media	2
1.2.2 Network Technology	2
1.2.3 Digital Signal Processing	4
1.3 The Development of Packet Video	5
References	8
Chapter 2 B-ISDN and Visual Communications	9
2.1 Introduction	9
2.2 The Digital Network Hierarchy	9
2.2.1 The Inception of Digitalization	9
2.2.2 Synchronous Digital Networks	10
2.2.3 Looking from ISDN to B-ISDN	13
2.2.4 STM and ATM	16
2.3 Visual Communications in Digital Networks	19
2.3.1 The Nature of Digital Images and Video	19
2.3.2 Burstiness of Digital Image and Video Transmission	23
2.4 Impacts and Issues of Packet Video Transmission	23
2.4.1 New Service Features	24
2.4.2 New Technological Issues	24
2.5 Summary	28
References	30

---

<b>Chapter 3</b>	<b>Characterization of Video Sources</b>	<b>33</b>
3.1	Introduction	33
3.2	Framework for Burstiness Evaluation	34
3.2.1	Video Sources	34
3.2.2	Encoding Schemes and Distortion	34
3.2.3	Time Scale for Burstiness Evaluation	35
3.2.4	Burstiness Measures	36
3.3	Characteristics of Teleconferencing Video	39
3.3.1	Sample Video Sequences	39
3.3.2	Encoding Schemes	39
3.3.3	Intrascene Bit-Rate Variations	40
3.3.4	Bit-Rate Distribution	42
3.3.5	Autocorrelation Functions	44
3.3.6	Coefficients of Variation	44
3.4	Characteristics of Broadcast TV	44
3.4.1	Sample Video Sequences	44
3.4.2	Encoding Algorithms	46
3.4.3	Temporal Variations in Bit Rate	47
3.4.4	Bit-Rate Distribution	49
3.4.5	Scene Duration	49
3.5	Other Reported Work	50
3.5.1	Characteristics of TV Telephone Video	51
3.5.2	Measurement Results from Actual Video Encoders	55
3.5.3	Scene Analysis of VCR-Quality Video	59
3.5.4	Scene-Independent Statistical Analysis of Long Video Sequences	62
3.6	Summary	62
	References	62
<b>Chapter 4</b>	<b>Video Signal Modeling for Prediction of Statistical Multiplexing</b>	<b>65</b>
4.1	Introduction	65
4.2	Fundamental Suppositions for Video Signal Modeling	66
4.2.1	Why Model Video Signals?	66
4.2.2	Classification of Bit-Rate Variability of Video Signals	67
4.2.3	Multiplexing Technique	68
4.3	Model of Intrascene Variation (Short-Term Variations)	69
4.3.1	Autoregressive Process Model	69
4.3.2	Evaluation of the Statistical Multiplexing Effect Using the AR Model	71
4.3.3	Markov Process Model	77
4.3.4	Evaluation of Average Delay Time Using Coefficients of Variation	83

---

4.4	Modeling Scene Changes	85
4.4.1	Simple Scene Change Modeling for a Single Video Source	86
4.4.2	Scene Change Modeling Using the Markov Process Model	90
4.4.3	Scene Change Modeling Using the Markov Modulated Poisson Process Model	92
4.4.4	Another Approach	95
4.5	Summary	96
	References	98
Chapter 5	Variable-Rate Video Coding	99
5.1	Introduction	99
5.2	Overview of a Variable-Rate Video Coding System	100
5.2.1	Functional Overview	100
5.2.2	Technological Issues	101
5.3	Quality Improvement by Variable-Rate Coding	103
5.3.1	Estimating Values with the Rate-Distortion Function	106
5.3.2	Evaluation of SNR Improvement via Simulation	108
5.3.3	Subjective Evaluations of Quality	110
5.4	Signal Processing in Variable-Rate Coding	115
5.4.1	Fundamental Compression Algorithms	115
5.4.2	Examples of Variable-Rate Video Codecs	125
5.5	Video Synchronization	137
5.5.1	Technique Based on Buffer Filling Level	137
5.5.2	Technique Based on Time Stamping	137
5.6	Summary	138
	References	139
Chapter 6	Packet Loss Protection and Recovery	141
6.1	Introduction	141
6.2	Varieties of Information Loss in Packet Networks	143
6.2.1	Errors Due to Electrical or Physical Causes	143
6.2.2	Data Losses Due to Inadequate Network Capacity	144
6.3	Overview of Protection and Recovery Techniques	144
6.3.1	Error Correction	144
6.3.2	Protection by Packet Priority	146
6.3.3	Structured Packing of Signals	147
6.3.4	Robust Coding/Decoding Schemes	153
6.3.5	Recovery by the Receiver	157
6.4	Layered Video Coding with Prioritized Packet Handling	160
6.4.1	The Meaning of Layers in Video Coding	160
6.4.2	Framework of Layering	161
6.4.3	Layered Coding Based on DCT	163
6.4.4	Layered Coding Based on Subband Partitioning	166

6.5	Video Quality in a Packet Loss Environment	169
6.5.1	Principle Factors Affecting Image Degradation	169
6.5.2	Video Quality with Layered DCT	172
6.6	Summary	180
	References	181
<b>Chapter 7</b>	<b>User/Network Interface for Packet Video</b>	<b>185</b>
7.1	Introduction	185
7.2	Packet Transmission by ATM Networks	185
7.2.1	Service Categories	185
7.2.2	Traffic Management Functions	187
7.2.3	Video Transmission Based on ATM Services	188
7.3	Usage Parameter Control	189
7.3.1	Basic UPC Algorithms: Peak and Average Rate Control	190
7.3.2	UPC Targeted for Video	193
7.4	Summary	195
	References	196
<b>Chapter 8</b>	<b>Conclusion</b>	<b>199</b>
	About the Author	201
	Index	203