Contents

Chapter 1 Introduction.....1

Chapter 2 Background 5

2.1 Video in Wireless Networks 5

2.2 Brief Introduction of H.264/AVC 7

2.2.1 Highlighted Features.....9

2.2.2 Network Abstraction Layer.....10

2.2.2.1 NAL units.....11

2.2.3 Video Coding Layer.....11

2.3 Scalable Coding.....16

2.3.1 Scalability and FGS Coding.....16

2.3.2 RFGS Coding.....18

2.3.3 H.264 + RFGS Coding.....20

2.4 Error Control Techniques 21

2.4.1 Tools of Error Resilience 21

2.4.1.1 Error Resilient Scalable Video Coding 21

2.4.1.2 Error Resilient Tools in H.264.....25

2.4.2 Tools of Error Concealment.....27

Chapter 3 Error Resilience of H.264 + RFGS.....33

3.1 Effects of Packet Length.....33

3.2 Quantization Parameter (QP).....37

3.3 Partial Prediction Parameter (β) 40

3.4 Leaky Factor (α).....42

3.5 Packaging Methods.....43

Chapter 4 Field Coding on H.264 + RFGS.....49

4.1 On Base Layer.....49

4.1.1 Proposed Types of Field Coding.....49

4.1.2 Error Concealment.....54

4.1.2.1 Error Concealment for Bottom Fields 55

4.1.2.2 Error Concealment for Top Fields 60

4.2 On Enhancement Layer 65

4.2.1 Proposed Structure.....65

4.2.2 Error Concealment 70

Chapter 5 Experiment Results 75

5.1 On Base Layer 75

5.2 On Enhancement Layer 83

Chapter 6 Conclusions 89

Bibliography 91

List of Tables

Table 3.1 Coding rate records 46

Table 4.1 Coding rate records of Field Coding 52

Table 4.2 Expectation of MD between current MB and its neighbor MB's 56

List of Figures

Fig. 2.1 Wireless video application MMS, PSS, and PCS: differentiation by real-time or offline processing for encoding, transmission, and decoding 6
Fig. 2.2 H.264/AVC standard in transport environment 6
Fig. 2.3 Packetization of an H.264/AVC NAL unit encapsulated in RTP/UDP/IP 7
Fig. 2.4 Structure of H.264/AVC 8
Fig. 2.5 Scope of H.264/AVC standardization 8
Fig. 2.6 NALU header 11
Fig. 2.7 Basic coding structure for H.264.AVC for a macroblock 12
Fig. 2.8 Subdivision of a picture into slices 13
Fig. 2.9 Subdivision of a picture into slice groups using FMO 13
Fig. 2.10 Five of the nine Intra 4x4 prediction modes 14
Fig. 2.11 Segmentations of a macroblock for motion compensation 14
Fig. 2.12 Performance of the deblocking filter for highly compressed pictures 16
Fig. 2.13 Illustration of video coding performance 17
Fig. 2.14 FGS scalability structure 18
Fig. 2.15 FGS encoder structure 18
Fig. 2.16 Diagram of RFGS partial inter-prediction mode 20
Fig. 2.17 Hybrid coding scheme of H.264+RFGS 21
Fig. 2.18 FEC across packets 23
Fig. 2.19 Transmission of an FGS stream containing n = 3 bit-planes 23
Fig. 2.20 Bit-stream packetization with cross layer UPP 24
Fig. 2.21 ARQ mechanism 25
Fig. 2.22 Two slice groups of checker-board FMO 27
Fig. 2.23 Spatial interpolation for error concealment 29
Fig. 2.24 Direction of the prediction motion vectors in an MPEG sequence 29
Fig. 2.25 Estimation of DCT coefficients of missing blocks based on neighboring blocks 30
Fig. 2.26 An example of the decision tree for error concealment 31

Fig. 3.1 Discussion of packet length 36
Fig. 3.2 Simulation results of error resilience performance of the single-layer H.264 38
Fig. 3.3 Simulation results of error resilience of H.264 +RFGS 39
Fig. 3.4 The coding efficiency for different choices of β 41
Fig. 3.5 PSNR performance versus bitrate with respect to various packet loss rates and different β's 42
Fig. 3.6 PSNR performance versus bitrates with respect to various packet loss rates and different α's 43
Fig. 3.7 The sequential packaging 45
Fig. 3.8 Two types of FMO packaging 45
Fig. 3.9 The field packaging 45
Fig. 3.10 Experiment Results (Foreman) 46
Fig. 3.11 Experiment Results (Stefan) 47
Fig. 4.1 A general prediction mode of frame coding 50
Fig. 4.2 Four prediction schemes of field coding 51
Fig. 4.3 Two basic error concealment methods 53
Fig. 4.4 Comparison of error resilience performance between FSPFC and frame coding 54
Fig. 4.5 Diagram of the relative positions between an MB and its neighbor MV's 56
Fig. 4.6 Power of differences of DCT coefficients versus motion vector errors 57
Fig. 4.7 Performance of the concealment method 'Spatial interpolation' 57
Fig. 4.8 Experimental result of spatial interpolation 58
Fig. 4.9 Simulation results of the 'Foreman' sequence 58
Fig. 4.10 Simulation results of the 'Foreman' sequence 59
Fig. 4.11 An illustration of the correlations between a bottom field and its reference fields 61
Fig. 4.12 A block (red) and its neighboring blocks (blue) 62
Fig. 4.13 Regions in the top field that are referred by MB's in the bottom field 62
Fig. 4.14 Simulation results of the 'Foreman' sequence 63
Fig. 4.15 Comparison of the error resilience between PPFC and FSPFC 65

Fig. 4.16 The structure of field coding over base layer + frame coding over enhancement layer 67
Fig. 4.17 The structure of field coding over base layer + field coding over enhancement layer 67
Fig. 4.18 The coding efficiency of H.264 + RFGS with frm-frm coding (blue), fld-frm coding (green), and fld-fld coding (red), respectively 68
Fig. 4.19 The coding efficiency of H.264 + RFGS with α = 1 (red), α = 0.6 (green), and α = 0.2 (blue) 69
Fig. 4.20 Comparison the vision effect of frame and field coding 70
Fig. 4.21 Simulation results of concealment methods 72
Fig. 4.22 Simulation results of concealment methods 74
Fig. 5.1 Base layer experiment results with the FSPFC structure (Foreman) 78
Fig. 5.2 Base layer experiment results. Comparison between the FSPFC structure and the frame coding structure (Test sequence: Foreman) 81
Fig. 5.3 Base layer experiment results. Comparison between the FSPFC structure and the frame coding structure (Test sequence: Stephan) 82
Fig. 5.4 Enhancement layer experiment results with the fld_fld coding (Test sequence: Foreman) 85
Fig. 5.5 Enhancement layer experiment results. Comparison between the fld_fld coding and the frm_frm coding (Test sequence: Foreman) 86
Fig. 5.6 Enhancement layer experiment results. Comparison between the fld_fld coding and the frm_frm coding (Test sequence: Stefan) 88