

Contents

1	Introduction	1
1.1	Image filtering	3
1.1.1	Weighted average filtering	4
1.1.2	Edge-aware/ Edge preserving filtering	6
1.1.3	Mathematical morphology	9
1.1.3.1	Morphological filter	10
1.1.4	Median filter	13
1.1.5	Non-Local approaches in image filtering	14
1.1.6	Structure preserving filtering	16
1.1.7	Applications	17
1.1.7.1	Image denoising	17
1.1.7.2	Image enhancement and tone mapping	18
1.1.7.3	Classification of hyperspectral images	19
1.1.7.4	Semantic segmentation of natural images	20
1.2	Challenges	20

1.2.1	Preservation of significant structures	22
1.2.1.1	Semantic features for preserving significant structures	22
1.2.1.2	Semantic-aware filtering	22
1.3	Evolution and developments of image filtering techniques	23
1.4	Methodologies/approaches	29
1.5	Experimental validation	32
1.5.1	Performance measure	33
1.5.2	Data sets	36
1.6	Objectives	37
1.7	Organization of the thesis	39
2	Semantic-aware structure preserving median morpho-filtering	41
2.1	Introduction	41
2.2	Morphological and median filters	43
2.2.1	Morphological filter	44
2.2.2	Median filter	44
2.3	Proposed technique [111]	45
2.3.1	Image gradients for edge detection	46
2.3.2	Generation of gradient image	48
2.3.3	Generation of edge-map	50

2.3.4	Median morpho-filtering	54
2.4	Experimental results and analysis	59
2.4.1	Qualitative comparison	60
2.4.2	Quantitative comparison	64
2.4.3	Parameters setting and analysis	65
2.4.4	Applications	67
2.4.4.1	Image denoising	67
2.4.4.2	Detail enhancement	69
2.4.4.3	Tone mapping	70
2.4.4.4	Edge detection	71
2.4.5	Computational performance analysis	73
2.5	Conclusions	74
3	Reduced parameter sensitive edge-aware semantic image filtering	76
3.1	Introduction	76
3.2	Proposed filtering technique	78
3.2.1	Generation of semantic edge-map	78
3.2.2	Approach I: Generation of semantic edge-map by direct use of JSD metric [110]	79
3.2.3	Approach II: Generation of semantic edge-map by extracting discriminating features using JSD	83

3.2.4	Generation of filtered image	87
3.3	Experimental analysis and results	87
3.3.1	Results: Filtered image obtained from the edge-map produced by Approach I	90
3.3.2	Results: Filtered image obtained from the edge-map produced by Approach II	93
3.3.2.1	Parameters setting	93
3.3.2.2	Qualitative Comparison	94
3.3.2.3	Quantitative Comparison	99
3.3.2.4	Applications	99
3.3.2.5	Computational analysis	102
3.3.2.6	Selection of optimal model (Model I or Model II)	103
3.4	Conclusions	104
4	A semantic edge-aware parameter efficient image filtering technique	106
4.1	Introduction	106
4.2	Proposed filtering technique [112]	107
4.2.1	Generation of semantic-aware edge-map	108
4.2.2	Edge-aware adaptive median filter	113
4.2.3	Parameters of the proposed technique	114
4.3	Experimental results and analysis	115

4.3.1	Qualitative comparison	120
4.3.2	Quantitative comparison	121
4.3.3	Applications	123
4.3.3.1	Image denoising	124
4.3.3.2	Detail enhancement	125
4.3.3.3	Tone mapping	125
4.3.4	Computational performance analysis	126
4.3.5	Limitations	126
4.4	Conclusions	127
5	Semantic-aware image filtering: Applications to classification of hyperspectral images and semantic segmentation of natural images	129
5.1	Introduction	129
5.2	Construction of Extended Semantic Filtered Profile (ESFP)	133
5.3	Data sets description	138
5.3.1	Indian Pines data set	138
5.3.2	Pavia University data set	139
5.3.3	Houston University data set	140
5.4	Experimental results	141
5.4.1	Experimental setting	141
5.4.2	Results analysis	143

Contents

5.5	Semantic segmentation of natural images	150
5.6	Conclusions	157
6	Conclusions and future scopes	159
6.1	Concluding remarks	159
6.2	Future scopes	164
7	Publication list	165