



**CLASSIFICATION METHODS
FOR REMOTELY SENSED DATA**

BRANDT TSO AND PAUL M. MATHER

Contents

Colour plates appear between pages 148 and 149

<i>Preface</i>	vii
1 Remote sensing in the optical and microwave regions	1
1.1 <i>Introduction to remote sensing</i> 5	
1.2 <i>Optical remote sensing systems</i> 11	
1.3 <i>Atmospheric correction</i> 12	
1.4 <i>Correction for topographic effects</i> 21	
1.5 <i>Remote sensing in the microwave region</i> 24	
1.6 <i>Radar fundamentals</i> 25	
1.7 <i>Imaging radar polarimetry</i> 33	
1.8 <i>Radar speckle suppression</i> 40	
2 Pattern recognition principles	54
2.1 <i>Feature space manipulation</i> 56	
2.2 <i>Feature selection</i> 67	
2.3 <i>A brief description of pattern recognition techniques</i> 68	
2.4 <i>Combining classifiers</i> 86	
2.5 <i>Incorporation of ancillary information</i> 87	
2.6 <i>Sampling scheme and sample size</i> 90	
2.7 <i>Estimation of classification accuracy</i> 95	
2.8 <i>Epilogue</i> 100	
3 Pattern recognition using artificial neural networks	102
3.1 <i>Multi-layer perceptron</i> 103	
3.2 <i>Kohonen's self-organising feature map</i> 114	
3.3 <i>Counter-propagation networks</i> 122	
3.4 <i>Hopfield networks</i> 125	
3.5 <i>Adaptive resonance theory (ART)</i> 133	

3.6 Neural networks in remote sensing image classification	140
4 Methods based on fuzzy set theory	149
4.1 Introduction to fuzzy set theory	150
4.2 Fuzzy c-means clustering algorithm	153
4.3 Fuzzy maximum likelihood classification	157
4.4 Fuzzy rule base	159
4.5 Image classification using fuzzy rules	169
4.6 Fuzzy classification: interpretation of mixed pixels	176
5 Texture quantisation	186
5.1 Fractal and multifractal dimensions	187
5.2 Frequency domain filtering	207
5.3 Grey level co-occurrence matrix (GLCM)	212
5.4 Multiplicative autoregressive random fields	216
5.5 The semivariogram and window size determination	219
5.6 Experimental analysis	223
6 Modelling context using Markov random fields	230
6.1 Markov random fields and Gibbs random fields	231
6.2 Construction of posterior energy	241
6.3 Robust M estimator	251
6.4 Parameter estimation	255
6.5 MAP-MRF classification algorithms	260
6.6 Experimental results	267
7 Multisource classification	271
7.1 Stacked-vector method	272
7.2 Incorporating topographic data	273
7.3 The extension of Bayesian classification theory	274
7.4 Evidential reasoning	281
7.5 Dealing with source reliability	289
7.6 Experimental results	295
<i>References</i>	299
<i>Index</i>	326