

Contents

Summary.....	9
Streszczenie.....	11
Acknowledgments	13
Notation.....	15
Preface.....	17
1. State of the art in Content-Based Image Retrieval.....	20
1.1. Surface descriptors.....	20
1.1.1. Colour descriptors	21
1.1.2. Ensuring colour constancy in colour-based retrieval	22
1.1.3. Texture descriptors.....	23
1.1.4. Similarity measures for surface descriptors	25
1.2. Keypoint descriptors and bag-of-features approach.....	25
1.3. Shape-based retrieval	27
1.3.1. Methods for shape-based retrieval – 2D approach	27
1.3.1.1. Basic region-based features	27
1.3.1.2. Curvature scale space.....	29
1.3.1.3. Retrieval by alignment.....	29
1.3.2. Methods for shape-based retrieval – 3D approach	30
1.3.2.1. Feature-based methods.....	31
1.3.2.2. Graph-based methods.....	32
1.3.2.3. Geometry-based methods.....	33
1.3.2.4. Creating 3D models from real objects	33
1.4. Relevance feedback: virtual query and distance-based retrieval.....	35
1.4.1. Interaction with the user and virtual queries	35
1.4.2. Rocchio formula.....	36
1.4.3. Combining features in the virtual query scheme	37
1.4.4. Shortcomings of CBIR based on virtual queries	38

2. Shape retrieval by alignment	39
2.1. Introduction to the Hausdorff distance.....	39
2.2. Formulation of recognition and retrieval as a multilevel optimisation problem	41
2.3. Efficient calculation of the Hausdorff distance.....	42
2.3.1. State of the art in increasing efficiency of the HD calculation.....	43
2.3.2. Contour approximation at the level L_1	45
2.3.3. Contour approximation at the level L_2	46
2.3.4. Contour pruning	49
2.3.4.1. Mathematical basis of the proposed contour pruning method	49
2.3.4.2. An application to contour recognition	50
2.3.4.3. Efficiency.....	51
2.3.4.4. Experimental time comparison	52
2.3.5. Optimisation in the transformation space.....	54
2.3.6. Database navigation and pruning	55
2.3.6.1. Using the triangle inequality for determining the search order	55
2.3.6.2. Using additional image features to increase the efficiency of the HD evaluation algorithms	57
2.3.6.3. Experimental time comparison	57
2.3.7. Summary of inaccuracies for the presented speeding-up methods.....	58
2.4. A practical application: 3D object retrieval by shape alignment	59
2.4.1. 3D modelling vs. direct silhouette matching.....	59
2.4.2. Dissimilarity measures	61
2.4.3. Implementation	63
3. Retrieval of non-homogeneous objects with preference approximation in feature spaces	66
3.1. General outline of matching scheme and selection of descriptors	66
3.2. Adaptation of distance-based method for complex objects.....	68
3.3. Approximation of user preferences by RBF	70
3.4. Experimental comparison of algorithms for non-homogeneous object retrieval	72
3.5. Conclusions.....	74
4. Elicitation of relevant features based on relational MCDM.....	75
4.1. Relevance feedback by pairwise comparisons	79
4.1.1. Pairwise comparisons and the Analytic Hierarchy Process.....	79
4.1.2. Basic AHP algorithm	80
4.1.3. The proposed algorithm for information retrieval.....	82
4.1.4. A practical application: an image retrieval system.....	87
4.1.5. Performance of the method	88
4.1.6. Conclusions.....	91
4.2. Relevance feedback by graph of relations	92
4.2.1. The concept of user criteria retrieval based on graph of relations.....	92
4.2.2. Criteria elicitation and information retrieval based on ELECTRE methodology	93
4.2.2.1. The ELECTRE III method.....	94
4.2.2.2. Proposed method for criteria elicitation	96
4.2.3. Application to Content-Based Image Retrieval.....	99

4.2.4. Performance and efficiency.....	103
4.3. Relevance feedback by individual assessment.....	105
4.3.1. Reference sets	105
4.3.2. The proposed algorithm for the criteria selection.....	106
4.3.3. An example of real-life application and performance assessment	108
4.4. Comparison of the performance and efficiency	113
5. Application of multicriteria image analysis and relevance feedback for the glass melting process control.....	116
5.1. Preliminary image processing: segmentation and mapping.....	117
5.1.1. Batch segmentation	119
5.1.2. Lens sediment segmentation	120
5.1.3. Image mapping.....	120
5.2. Analysis of temperature symmetry	122
5.2.1. Batch blanket asymmetry indicator	122
5.2.2. Calculation of CCT	124
5.2.3. The influence of reversals on temperature distribution asymmetry	126
5.2.4. Areas of batch symmetry and glass symmetry	127
5.2.5. Cross indicators of temperature asymmetry	128
5.2.6. Inferring about process settings from the asymmetry indicators.....	130
5.2.7. An example of the analysis of melting symmetry	131
5.3. Elicitation of melting criteria based on pairwise comparisons.....	135
5.3.1. Preliminary image processing and the calculation of potential criteria....	136
5.3.2. The backward AHP and its application in the elicitation of relevant criteria	137
5.3.3. Elicitation of relevant parameters.....	141
5.4. Summary of the results and conclusions.....	144
6. Final conclusions	147
References	149