



A Study on Image Change Detection Methods for Multiple Images of the Same Scene Acquired by a Mobile Camera

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TABLE OF CONTENTS

TITLE OF PAGE	i
TABLE OF CONTENTS	ii
LIST OF FIGURES	vi
LIST OF TABLES	xv
NOMENCLATURE	xvii
ABSTRACT	xix
STATEMENT OF ORIGINALITY	xxi
PUBLICATIONS	xxii
ACKNOWLEDGEMENTS	xxiii
1 INTRODUCTION	1
1.1 Background and Motivation	1
1.2 Problems, Objectives and Scopes	3
1.3 Structure of the Thesis	6
2 LITERATURE REVIEW	8
2.1 Image Registration	8
2.2 Stereo Correspondence Algorithms	13
2.3 Change Detection Algorithms for Static Cameras	15
2.4 Change Detection Algorithms for Mobile Cameras	20
2.5 Summary of Literature	22
3 Indoor Change Detection Method	25
3.1 Background	25
3.2 Algorithm Overview	26
3.2.1 Automatic Image Registration	26

3.2.2	Temporal Differencing	27
3.2.3	Unimportant Changes Removal	28
3.3	Reference and Input Images	29
3.4	Experimental Results and Discussion	31
3.4.1	Subjective Evaluation	43
3.5	Concluding Remarks	44
4	Automatic Control Points Extraction	45
4.1	Background	45
4.2	Algorithm Overview	46
4.3	Reference and Input Images	48
4.4	Experimental Results and Discussion	54
4.5	Concluding Remarks	61
5	Automatic Image Registration and Regions of Interest Extraction	63
5.1	Background	63
5.2	Algorithm Overview	64
5.3	Experimental Results and Discussion	64
5.4	Concluding Remarks	71
6	Confidence Map and Occlusion Map Images Generation	73
6.1	Background	73
6.2	Confidence Map Image Making	74
6.3	Occlusion Map Image Making	76
6.4	Experimental Results and Discussion	78
6.5	Concluding Remarks	87
7	Detecting of Objects Absence and Presence behind Fence Wires	89
7.1	Background	89
7.2	Algorithm Overview	90
7.3	First Hybrid Decision-Making System	94
7.3.1	First Crisp Inference System	94
7.3.2	First Fuzzy Inference System (FIS1)	97
7.4	Template Subtraction Approach	102
7.5	Changed Masks	110

7.6	Concluding Remarks	112
8	Detecting Edges of Fence Wires	114
8.1	Background	114
8.2	Algorithm Overview	116
8.2.1	The Sobel Edge Detector	116
8.2.2	An Adaptive Threshold Technique	117
8.3	Experimental Results and Discussion	118
8.4	Concluding Remarks	128
9	Detecting Breaches in the Integrity of and Attached Objects in front of Fence Wires	130
9.1	Background	130
9.2	Algorithm Overview	131
9.2.1	Detecting Edges of Fence Wires	131
9.2.2	Enhancing Edges of Fence Wires	132
9.2.3	Removing Diamond-Shape Areas	132
9.2.4	The Second Hybrid Decision-Making System	134
9.3	Experimental Results	137
9.4	Changed Masks	145
9.5	Concluding Remarks	148
10	Experimental Results and Discussion	150
10.1	Third Fuzzy Inference System (FIS3)	150
10.2	Experimental Results	153
10.2.1	First Outdoor Scene	153
10.2.2	Second Outdoor Scene	159
10.2.2.1	Reference and Input Images	159
10.2.2.2	Changed Masks	163
10.2.2.3	Locations of Changes	167
10.2.3	Third Outdoor Scene	172
10.2.3.1	Reference and Input Images	172
10.2.3.2	Changed Masks	176
10.2.3.3	Locations of Changes	180

10.3	Discussion	184
10.3.1	Subjective Quality Evaluation	185
10.3.2	Quantitative Evaluation	188
10.3.3	Computational Time Consumption	196
10.3.4	The Effect of Camera Movement and Rotation Restrictions on the Performance of the Method .	199
10.3.5	The Effect of Object Shadows on the Performance of the Method	200
10.4	Concluding Remarks	201
11	Conclusions and Future Work	203
11.1	Conclusions of the Research	203
11.2	Summary of Main Contributions	207
12.3	Recommendations for Future Work	208
APPENDIX 1	210
REFERENCES	216

LIST OF FIGURES

1.1	An airport marked by a chain-link mesh fence. The wire fence is used in preventing intruders to get into the airport.....	2
3.1	Flow chart of the indoor change detection method.....	26
3.2	The reference image utilized in this indoor experiment. It was a scene of an indoor environment that consisted of objects such as books, pictures, a wall and a table.....	29
3.3	Top views of input camera positions. As seen in Fig. 3.3, the mobilecamera has been shifted on the three degrees of freedom ((X, Y, $\Delta\theta_z$) axes).....	31
3.4	Input images used in this indoor experiment.....	32
3.5	Templates extracted in advance from the reference image.....	31
3.6	A sample of matched keypoints provided by the SIFT operator.....	33
3.7	Matched keypoints provided the SIFT operator from the template 2, 3 and the IdII-7. The SIFT operator extracted 74 keypoints from the template 2, 25 keypoints from the template 3 and 691 keypoints from the IdII-7. Matched keypoints found by the SIFT operator from the template 2 and the IdII-7, and from the template 3 and the IdII-7 were 29 and 4 matches.....	34
3.8	Control points extracted automatically from the reference image (a) and the IdII-7 (b).....	34
3.9	The registered IdII-7. As seen in Fig. 3.9, occluded regions in left side of the image has been automatically removed as a result of image registration.....	36
3.10	The subtracted image produced after subtracting the reference image and the IdII-7.....	36
3.11	The preliminary changed mask.....	37
3.12	The result of suppression objects that touch that image border.....	38

3.13	The result of vertical and horizontal erosion.....	38
3.14	The final changed mask produced after removing small objects less than 100 pixels.....	39
3.15	Locations of significant changes on the registered IdII-7.....	39
3.16	Results of applying automated image registration towards the IdII-1 (a), IdII-2 (b), IdII-3 (c), IdII-4 (d), IdII-5 (e), IdII-6 (f) and IdII-8(g).....	40
3.17	Changed masks of the IdII-1 (a), IdII-2 (b), IdII-3 (c), IdII-4 (d), IdII-5 (e), IdII-6 (f) and IdII-8(g) generated by the indoor change detection method.....	41
3.18	Locations of significant changes detected by the indoor change detection method from the IdII-1 (a), IdII-2 (b), IdII-3 (c), IdII-4 (d), IdII-5 (e), IdII-6 (f) and IdII-8 (g).....	42
4.1	The AIO1_RI and AIO1_II are separated into four regions: I, II, III and IV. Regions I and IV contain the left post and right post of fence wires. Searching of SIFT keys is only performed in regions I and IV in order to reduce errors of SIFT keys matching between SIFT keys extracted in the template_RI and SIFT keys detected in regions I and IV of the AIO1_RI or the AIO1_II.....	48
4.2	Top views of the mobile camera positions when capturing the 13 outdoor images of the same scene containing fence wires.....	49
4.3	The reference image used in this outdoor experiment.....	49
4.4	The II-1 (a), II-5 (b) and II-9 (c) were captured by a mobile camera at slightly different positions, angles and at slightly different times. These input camera positions simulate that the mobile camera could be in one of these positions in the real time application.....	51
4.5	The II-2 (a), II-6 (b) and II-10 (c) were captured by a mobile camera at slightly different positions, angles and at slightly different times. These input camera positions simulate that the mobile camera could be in one of these positions in the real time application.....	52
4.6	The II-3 (a), II-7 (b) and II-11 (c).....	53
4.7	The II-4 (a), II-8 (b) and II-12 (c) were acquired from slightly	

	different positions, angles and at slightly different times.....	53
4.8	A human-made template is picture of a building.....	55
4.9	The AOI1_RI cropped automatically from the reference image.....	55
4.10	Regions I (a) and IV (b) cropped automatically from the reference image. Both regions contain left and right posts of the wire fence.....	56
4.11	The SIFT operator extracts 126 matched keypoints from the template_RI and region I of the AOI1_RI.....	56
4.12	The SIFT operator extracts 23 matched keypoints from the template_RI and region IV of the AOI1_RI.....	57
4.13	Two CPs are automatically extracted from left and right posts of the wire fence with a template-based matching approach by using the SIFT operator in the AOI1_RI.....	57
4.14	CPs extracted automatically from the AOI1_II-1 (a), AOI1_II-5 (b) and AOI1_II-9 (c).....	58
4.15	CPs detected from the AOI1_II-2 (a), AOI1_II-6 (b) and AOI1_II-10 (c).....	59
4.16	CPs detected from the AOI1_II-3 (a), AOI1_II-7 (b) and AOI1_II-11 (c).....	59
4.17	CPs detected from the AOI1_II-4 (a), AOI1_II-8 (b) and AOI1_II-12 (c).....	60
5.1	The RAOI1_II-1 (a), RAOI1_II-5 (b) and RAOI1_II-9 (c).....	65
5.2	The ROI2_II-1 (a) and ROI2_RI-1 (b). Both images are cropped automatically based on the same bounding box parameters extracted from the RAOI1_II-1.....	66
5.3	The ROI2_II-5 (a) and ROI2_II-9 (b) extracted from the RAOI1_II-5 and RAOI1_II-9 by using information of their own bounding box parameters.....	66
5.4	The ROI1_II-2 (a), ROI1_II-6 (b) and RAOI1_II-10 (c) produced after performing image registration by using their CPs.....	67
5.5	The ROI2_II-2 (a), ROI2_II-6 (b) and ROI2_II-10 (c) extracted from the RAOI1_II-2, RAOI1_II-6 and RAOI1_II-10 by using their bounding box parameters.....	67

5.6	The registered AOI1_II-3 (a), registered AOI1_II-7 (b) and registered AOI1_II-11 (c) after performing image registration by using their CPs.....	68
5.7	The ROI2_II-3 (a), ROI2_II-7 (b) and ROI2_II-11 (c) extracted from the RAOI1_II-3, RAOI1_II-7 and RAOI1_II-11 based on information of their own bounding box parameters.....	68
5.8	The RAOI1_II-4 (a), RaOI1_II-8 (b) and RAOI1_II-12 (c) produced after performing image registration.....	69
5.9	The ROI2_II-4 (a), ROI2_II-8 (b) and ROI2_II-12 (c) cropped from the RAOI1_II-4, RAOI1_II-8 and RAOI1_II-12 by using information of their bounding box parameters.....	69
5.10	The subtracted image between the ROI2_II-1 and the ROI2_RI-1.....	70
6.1	The CMI_II-1 (a), CMI_II-5 (b) and CMI_II-9 (c) produced by the ZKA.....	79
6.2	The CMI_II-2 (a), CMI_II-6 (b) and CMI_II-10 (c) produced by the ZKA.....	81
6.3	The CMI_II-3 (a), CMI_II-7 (b) and CMI_II-11 (c) generated by the ZKA.....	82
6.4	The CMI_II-4 (a), CMI_II-8 (b) and CMI_II-12 (c) produced by the ZKA in which the ROI2_RI-4 and ROI2_II-4, the ROI2_RI-8 and ROI2_II-8, and the ROI2_RI-12 and ROI2_II-12 were used as inputs.....	83
6.5	A binary image of the CMI_II-1 after performing brightness thresholding.....	84
6.6	Objects whose sizes in the range of 700 – 16,000 pixels.....	84
6.7	Objects whose eccentricity values lower than 0.98.....	85
6.8	The OMI_II-1 produced from the CMI_II-1.....	85
6.9	The OMI_II-5 (a) and OMI_II-9 (b).....	86
6.10	The OMI_II-2 (a), OMI_II-6 (b) and OMI_II-10 (c).....	86
6.11	The OMI_II-3 (a), OMI_II-7 (b) and OMI_II-11 (c).....	86
6.12	The OMI_II-4 (a), OMI_II-8 (b) and OMI_II-12 (c).....	87

7.1	Removing occluded regions based on their positions in Y axis.....	95
7.2	Results of applying the crisp inference system to the OMI_II-5 (a) and OMI_II-9 (b).....	95
7.3	Results of applying the crisp inference system to the OMI_II-2 (a), OMI_II-6 (c) and OMI_II-10 (c).....	96
7.4	Results of applying the crisp inference system to the OMI_II-3 (a), OMI_II-7 (c) and OMI_II-11 (c).....	96
7.5	Results of applying the crisp inference system to the OMI_II-4 (a), OMI_II-8 (c) and OMI_II-12 (c).....	96
7.6	The first fuzzy inference system (FIS1).....	99
7.7	The HDS1_II-1 (a), HDS1_II-5 (b) and HDS1_II-9 (c).....	101
7.8	The HDS1_II-2 (a), HDS1_II-6 (b) and HDS1_II-10 (c).....	101
7.9	The HDS1_II-3 (a), HDS1_II-7 (b) and HDS1_II-11 (c).....	101
7.10	The HDS1_II-4 (a), HDS1_II-8 (b) and HDS1_II-12 (c).....	102
7.11	Two templates cropped from the ROI2_RI-1 (a) and ROI2_II-1 (b) based on information of bounding box parameters of an object in the HDS1_II-1.....	104
7.12	The subtracted image of both templates.....	105
7.13	The binary image after applying an automated global thresholding.....	105
7.14	The result of searching a big object in the binary image in Fig. 7.13. When an empty image is produced by the template subtraction approach, a false logic (0) is produced to indicate that there is no disappearing and/or appearing of an object in both templates.....	105
7.15	Two new templates cropped from the ROI2_RI-1 (a) and ROI2_II-1 (b) based on information of bounding box parameters of another object in the HDS1_II-1.....	106
7.16	The subtracted image between both templates in Figs. 7.15 (a) and (b)...	107
7.17	The binary image produced after performing an automated global thresholding.....	107
7.18	The result of searching a big object in the binary image.....	108
7.19	Two new templates cropped from the ROI2_RI-1 (a) and ROI2_II-1 (b)..	108
7.20	The subtracted image (a) of both templates in Figs. 7.19 (a) and (b),	

and the binary image (b) after performing an automated global thresholding.....	108
7.21 The result of searching big objects that have sizes equal or greater than 8,000 pixels in the binary image in Fig. 7.20 (b).....	109
7.22 The CHM1_II-1 generated from the OMI_II-1.....	109
7.23 The CHM1_II-5 (a) and CHM1_II-9 (b).....	110
7.24 The CHM1_II-2 (a), CHM1_II-6 (b) and CHM1_II-9 (c).....	110
7.25 The CHM1_II-3 (a), CHM1_II-7 (b) and CHM1_II-11 (c).....	111
7.26 The CHM1_II-4 (a), CHM1_II-8 (b) and CHM1_II-12 (c).....	112
8.1 The edged image, $E_{II-1}(i, j)$, produced after performing the Sobel edge detector into the ROI21_II-1.....	118
8.2 Enlarging the small left bottom part of the edged image.....	119
8.3 The binary image, $(BW_{II-1}(x, y))$, generated after performing the adaptive thresholding into the $E_{II-1}(i, j)$	120
8.4 Edged images of the ROI2_II-5 (a) and ROI2_II-9 (b).....	120
8.5 Edged images of the ROI2_II-2 (a), ROI2_II-6 (b) and ROI2_II-10 (c)...	121
8.6 Edged images detected from the ROI2_II-3 (a), ROI2_II-7 (b) and ROI2_II-11 (c).....	122
8.7 Edged images extracted from the ROI2_II-4 (a), ROI2_II-8 (b) and ROI2_II-12 (c).....	123
8.8 Binary images extracted from the $E_{II-5}(i, j)$ (a) and $E_{II-9}(I, j)$ (b) after applying the adaptive thresholding technique.....	124
8.9 Binary images (i.e., $BW_{II-2}(x, y)$, $BW_{II-6}(x, y)$ and $BW_{II-10}(x, y)$) detected from the $E_{II-2}(i, j)$ (a), $E_{II-6}(i, j)$ (b) and $E_{II-10}(i, j)$ (c).....	125
8.10 Binary images generated from the $E_{II-3}(i, j)$ (a), $E_{II-7}(i, j)$ (b) and $E_{II-11}(i, j)$ (c) after performing the adaptive thresholding.....	126
8.11 Binary images (i.e., $BW_{II-4}(x, y)$, $BW_{II-8}(x, y)$ and $BW_{II-12}(x, y)$) extracted from the $E_{II-4}(i, j)$ (a), $E_{II-8}(i, j)$ (b) and $E_{II-12}(i, j)$ (c).....	127

9.1	The BW_3_{II-1} (a), BW_3_{II-5} (b) and BW_3_{II-9} (c).....	138
9.2	The BW_3_{II-2} (a), BW_3_{II-6} (b) and BW_3_{II-10} (c).....	139
9.3	Te BW_3_{II-3} (a), BW_3_{II-7} (b) and BW_3_{II-11} (c).....	140
9.4	The BW_3_{II-4} (a), BW_3_{II-8} (b) and BW_3_{II-12} (c).....	141
9.5	The CM_4_{II-1} (a), CM_4_{II-5} (b) and CM_4_{II-9} (c).....	142
9.6	The CM_4_{II-2} (a), CM_4_{II-6} (b) and CM_4_{II-10} (c).....	142
9.7	The CM_4_{II-3} (a), CM_4_{II-7} (b) and CM_4_{II-11} (c).....	143
9.8	The CM_4_{II-4} (a), CM_4_{II-8} (b) and CM_4_{II-12} (c).....	143
9.9	The CM_5_{II-1} (a), CM_5_{II-5} (b) and CM_5_{II-9} (c).....	144
9.10	The CM_5_{II-2} (a), CM_5_{II-6} (b) and CM_5_{II-10} (c).....	144
9.11	The CM_5_{II-3} (a), CM_5_{II-7} (b) and CM_5_{II-11} (c).....	145
9.12	The CM_5_{II-4} (a), CM_5_{II-8} (b) and CM_5_{II-12} (c).....	145
9.13	Changed masks extracted by the second algorithm from the ROI2_II-1 (a), ROI2_II-5 (b) and ROI2_II-9 (c).....	146
9.14	Changed masks detected by the second algorithm from the ROI2_II-2 (a), ROI2_II-6 (b) and ROI2_II-10 (c).....	146
9.15	Changed masks produced by the second algorithm from the ROI2_II-3 (a), ROI2_II-7 (b) and ROI2_II-11 (c).....	147
9.16	Changed masks extracted by the second algorithm from the ROI2_II-4 (a), ROI2_II-8 (b) and ROI2_II (c).....	148
10.1	Estimated locations and latest possible percentage values of significant changes detected by the change detection method from the ROI2_II-1 (a), ROI2_II-5 (b) and ROI2_II-9 (c).....	154
10.2	Detection results provided by the change detection method from the ROI2_II-2 (a), ROI2_II-6 (b) and ROI2_II-10 (c).....	156
10.3	Estimated locations and possible percentages of significant changes produced by the change detection method from the ROI2_II-3 (a), ROI2_II-7 (b) and ROI2_II-11 (c).....	157
10.4	Detection results produced by the change detection method from the ROI2_II-4 (a), ROI2_II-8 (b) and ROI2_II-12 (c).....	158
10.5	The reference image taken from the second outdoor scene.....	160

10.6	The II-1 (a), II-5 (b) and II-9 (c) captured from the second outdoor scene.....	161
10.7	The II-2 (a), II-6 (b) and II-10 (c) taken from the second outdoor scene.....	161
10.8	The II-3 (a), II-7 (b) and II-11 (c) taken from the second outdoor scene.....	162
10.9	The II-4 (a), II-8 (b) and II-12 (c) taken from the second outdoor scene.....	162
10.10	The small breach that appears in the integrity of fence wires.....	163
10.11	The CHM1_II-1 (a), CHM1_II-5 (b) and CHM1_II-9 (c).....	164
10.12	The CHM1_II-2 (a), CHM1_II-6 (b) and CHM1_II-10 (c).....	164
10.13	The CHM1_II-3 (a), CHM1_II-7 (b) and CHM1_II-11 (c).....	164
10.14	The CHM1_II-4 (a), CHM1_II-8 (b) and CHM1_II-12 (c).....	165
10.15	The CHM2_II-1 (a), CHM2_II-5 (b) and CHM2_II-9 (c).....	165
10.16	The CHM2_II-2 (a), CHM2_II-6 (b) and CHM2_II-10 (c).....	166
10.17	The CHM2_II-3 (a), CHM2_II-7 (b) and CHM2_II-11 (c).....	166
10.18	The CHM2_II-4 (a), CHM2_II-8 (b) and CHM2_II-12 (c).....	167
10.19	Estimated locations and possible percentages of significant changes provided by the outdoor change detection method from the ROI2_II-1 (a), ROI2_II-5 (b) and ROI2_II-9 (c).....	168
10.20	Estimated locations and possible percentages of significant changes provided by the outdoor change detection method from the ROI2_II-2 (a), ROI2_II-6 (b) and ROI2_II-10 (c).....	169
10.21	Estimated locations and possible percentages of significant changes provided by the outdoor change detection method from the ROI2_II-3 (a), ROI2_II-7 (b) and ROI2_II-11 (c).....	170
10.22	Estimated locations and possible percentages of significant changes provided by the outdoor change detection method from the ROI2_II-4 (a), ROI2_II-8 (b) and ROI2_II-12 (c).....	171
10.23	The reference image taken from the third outdoor scene.....	173
10.24	The II-1 (a), II-5 (b) and II-9 (c) captured from the third outdoor scene..	174
10.25	The II-2 (a), II-6 (b) and II-10 (c) taken from the third outdoor scene....	174

10.26	The II-3 (a), II-7 (b) and II-11 (c) taken from the third outdoor scene....	175
10.27	The II-4 (a), II-8 (b) and II-12 (c) taken from the third outdoor scene....	175
10.28	The CHM1_II-1 (a), CHM1_II-5 (b) and CHM1_II-9 (c).....	176
10.29	The CHM1_II-2 (a), CHM1_II-6 (b) and CHM1_II-10 (c).....	177
10.30	The CHM1_II-3 (a), CHM1_II-7 (b) and CHM1_II-11 (c).....	177
10.31	The CHM1_II-4 (a), CHM1_II-8 (b) and CHM1_II-12 (c).....	177
10.32	The CHM2_II-1 (a), CHM2_II-5 (b) and CHM2_II-9 (c).....	178
10.33	The CHM2_II-2 (a), CHM2_II-6 (b) and CHM2_II-10 (c).....	179
10.34	The CHM2_II-3 (a), CHM2_II-7 (b) and CHM2_II-11 (c).....	179
10.35	The CHM2_II-4 (a), CHM2_II-8 (b) and CHM2_II-12 (c).....	179
10.36	Estimated locations and possible percentages of significant changes provided by the outdoor change detection method from the ROI2_II-1 (a), ROI2_II-5 (b) and ROI2_II-9 (c).....	181
10.37	Estimated locations and possible percentages of significant changes provided by the outdoor change detection method from the ROI2_II-2 (a), ROI2_II-6 (b) and ROI2_II-10 (c).....	182
10.38	Estimated locations and possible percentages of significant changes provided by the outdoor change detection method from the ROI2_II-3 (a), ROI2_II-7 (b) and ROI2_II-11 (c).....	183
10.39	Estimated locations and possible percentages of significant changes provided by the outdoor change detection method from the ROI2_II-4 (a), ROI2_II-8 (b) and ROI2_II-12 (c).....	184
10.40	A ground truth image extracted from the multiple outdoor images of the first outdoor scene used to asses the performance of the change detection method.....	189
10.41	A ground truth image extracted from new images captured from the second outdoor scene used to evaluate the performance of the change detection method.....	192
10.42	A ground truth image extracted from new images captured from the third outdoor scene used to evaluate the performance of the change detection method.....	194

LIST OF TABLES

3.1	Camera positions when capturing input images.....	30
3.2	The result of tuning process.....	35
3.3	Summarization of change detection results.....	43
4.1	Summarization of positions and times when capturing the reference image and input images used in this research.....	54
4.2	Summarization of matched keypoints extracted from left and right posts of the wire fence in each input image.....	61
5.1	Summarization of translation, scaling and rotation values of each RAOI1_II.....	70
6.1	Summarization of the ZKA parameters used in this study.....	74
6.2	Summarization of ρ values.....	78
9.1	Summarization of $avgV$ values. d denotes the distance between a mobile-camera and fence wires in meter, s stands for a file size in Megabytes, w is the width of fence-wires in pixels and $avgV$ was calculated by multiplying w with 1000 pixels. In this study, the file size of each input image was 8 MB and d was 6 m. Hence, the $avgV$ value was setup constant for any input image at 3000 pixels.....	134
9.2	An overview of the FIS2 including its inputs, outputs, and fuzzy rules. I_1, I_2, I_3 and I_4 denote X-BoundingBox, Y-BoundingBox, Eccentricity and Xwidth. O symbolizes Probabilityaschange.....	136
9.3	Summarization of triangular membership function parameters.....	137
10.1	An overview of the FIS3 including its inputs, outputs, and fuzzy rules. a, b, c and d denote Area, y_width, x_width , and $AbsDiffLF$. O symbolizes Probabilityaschange.....	152

10.2	Summarization of triangular membership function parameters.....	153
10.3	Summarization of camera positions and times when capturing 13 new images from the second outdoor scene.....	159
10.4	Summarization of camera positions and times when capturing 13 new images from the third outdoor scene.....	172
10.5	Summarization of detection results produced by the outdoor change detection method towards multiple outdoor images of the same scene taken from the first outdoor scene.....	186
10.6	Summarization of detection results produced by the outdoor change detection method after applying new multiple outdoor images of the same scene taken from the second outdoor scene.....	187
10.7	Summarization of detection results produced by the outdoor change detection method after applying new multiple outdoor images of the same scene taken from the third outdoor scene.....	188
10.8	Summarization of object areas in Kbytes extracted from the ground truth image in Fig. 10.40 above.....	189
10.9	Summarization of TP, FN, FP and TN numbers in Kbytes.....	190
10.10	Summarization of object areas in Kbytes extracted from the ground truth image in Fig. 10.41 above.....	192
10.11	Summarization of TP, FN, FP and TN values in Kbytes.....	193
10.12	<i>TPR, FNR, TNR, FPR</i> , R, P and F values of the outdoor change detection method produced by the ground truth measure.....	193
10.13	Summarization of object areas in Kbytes extracted from the ground truth image in Fig. 10.42 above.....	195
10.14	Summarization of TP, FN, FP and TN values in Kbytes.....	195
10.15	<i>TPR, FNR, TNR, FPR</i> , R, P and F values of the outdoor change detection method produced by the ground truth measure.....	196
10.16	Time consumptions needed the computer to process each input image....	197
10.17	Time consumptions needed the computer to process new images captured from the second outdoor scene.....	198
10.18	Time consumptions needed the computer to process new images captured from the third outdoor scene.....	199

NOMENCLATURE

Acronyms

CCTVs	Close-Circuit Televisions
IR	Infra-Red
GPS	Global Position System
VMD	Video Motion Detection
3DOF	Three Degrees of Freedom
PZT	Pan-Zoom-Tilt
FFT	Fast Fourier Transform
MP	Morphological Pyramid
GA	Genetic Algorithm
RGB	Red, Green and Blue
HSV	Hue, Saturation and Value
AIR	Automatic Image Registration
UCHR	Unimportant Changes Removal
RoiD	Region of Interest of the Subtracted Image
SIFT	Scale Invariant Feature Transform
IdII	Indoor Input Image
NCC	Normalized Cross-Correlation
TP	True Positive
FP	False Positive
FN	False Negative
TPR	True Positive Rate
FNR	False Negative Rate
CPs	Control Points
Template_RI	Human-Made Template
AIO1_RI	Area of Interest of Reference Image

AOI1_II	Area of Interest of Input Image
3DOF	Three Degrees of Freedom
II	Input Image for Outdoor Experiment
ROI2_RI	New Region of Interest of the AOI1_RI
ROI2_II	New Region of Interest of the RAOI1_II
RAOI1_II	Registered AOI1_II
ZKA	The Zitnick and Kanade Algorithm
OMI	Occlusion Map Image
CMI	Confidence Map Image
OMI_II	Occlusion Map Image of Input Image
CMI_II	Confidence Map Image of Input Image
MSS	Landsat Multispectral Scanner
TM	Landsat Thematic Mapper
MR	Magnetic Resonance
PET	Positron Emission Tomography
HDS1_II_s	First Hybrid Decision-Making System Input Images
FIS1	First Fuzzy Inference System
CHM1_II	Changed Mask Generated by the First Algorithm
E_II-1(i, j)	The Edged Image of the ROI2_II-1
BW_II-1(x, y)	The Binary Image of the E_II-1(i, j)
HDS2	Second Hybrid Decision-Making System
FIS2	Second Fuzzy Inference System
CHM2_II	Changed Mask Produced by the Second Algorithm

ABSTRACT

Detecting regions of change while reducing unimportant changes in multiple outdoor images of the same scene containing fence wires (i.e., a chain-link mesh fence) acquired by a mobile camera from slightly different viewing positions, angles and at different times is a very difficult problem. Regions of change include appearing of new objects and/or disappearing of old objects behind fence wires, breaches in the integrity of fence wires and attached objects in front of fence wires. Unimportant changes are mainly caused by camera movement, considerable background clutter, illumination variation, tiny sizes of fence wires and non-uniform illumination that occurs across fence wires. There are several issues that arise from these kinds of multiple outdoor images. The issues are: (1) parallax (the apparent displacement of an object as seen from two different positions that are not on a line with the object) among objects in the scene, (2) changing in size of same objects as a result of camera movement in forward or backward direction, (3) background clutter of outdoor scenes, (4) thinness of fence wires and (5) significant illumination variation that occurs in outdoor scenes and across fence wires. In this dissertation, an automated change detection method is proposed for these kinds of multiple outdoor images.

The change detection method is composed of two distinct modules, which are a module for detecting object presence and/or absence behind fence wires and another module for detecting breaches in the integrity of fence wires and/or attached objects in front of fence wires. The first module consists of five main steps: (1) automated image registration, (2) confidence map image production by the Zitnick and Kanade algorithm, (3) occlusion map image generation, (4) significant or unimportant changes decision by the first hybrid decision-making system and (5) false positives reduction by the template subtraction approach. The second module integrates: (1) the Sobel edge detector combined with an adaptive thresholding technique in extracting edges of fence wires, (2) an area-based measuring in separating small and

big objects based on their average areas determined once in the calibration process and (3) the second hybrid decision-making system in classifying objects as significant or unimportant changes.

Experimental results demonstrate that the change detection method can identify and indicate approximate locations and possible percentages of significant changes whilst reducing unimportant changes in these kinds of multiple outdoor images. The study has utilized occluded regions in a confidence map image produced by the Zitnick and Kanade algorithm as potential significant changes in the image change detection research. Moreover, the study proves that the use of the Sobel edge detector combined with an adaptive thresholding technique is applicable in extracting edges of outdoor fence wires. In the future, the method could be integrated into patrol robots in order to provide assistance to human guards in protecting outdoor perimeter security.

STATEMENT OF ORIGINALITY

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