

Contents

Chinese Abstract	i
English Abstract	ii
Acknowledgement	iii
Contents	iv
Index of Figures	vi
Index of Tables	ix
Chapter 1 Introduction	1
1.1 Preliminary	1
1.2 The Procedures of Image Stitching Process	2
Chapter 2 Camera Calibration	4
2.1 Introduction	4
2.2 Camera Calibration Model	5
2.3 Matlab Toolbox for Camera Calibration.....	6
Chapter 3 Image Registration	11
3.1 Introduction	11
3.2 Feature Points Extraction	11
3.3 Feature Matching.....	14
Chapter 4 Image Mapping	18
4.1 Introduction	18
4.2 Optimal Mapping.....	19
4.3 Random Sample Consensus	22
4.4 Image Compensation	24

Chapter 5 Image Stitching	28
5.1 Introduction	28
5.2 Rectangular Boundary Determination.....	29
5.3 Previous Researches for Image Stitching.....	32
5.3.1 Minimum Error Boundary Cut	32
5.3.2 Optimal Partition	33
Chapter 6 Novel Image Stitching Technique	36
6.1 Introduction	36
6.2 The Defects of the Previous Researches.....	36
6.3 Novel Image Stitching Technique	38
6.3.1 Determination of Main Cut Line Direction	38
6.3.2 Brightness Normalization.....	40
6.3.4 Image Blending	50
Chapter 7 Experimental Results	54
7.1 Introduction	54
7.2 Scenery Resolution Enhancement.....	54
7.3 Panoramic Construction	57
7.3.1 Wide Sight Panoramic Construction	57
7.3.2 Surrounding Panoramic Construction	60
7.4 Unsuitable Stitching Conditions.....	62
7.4.1 Color difference.....	62
7.4.2 Position Mismatching.....	63
7.4.3 Failed Stitching.....	64
Chapter 8 Conclusions	65
8.1 Conclusion.....	65
8.2 Feature Work	66
Reference	67

Index of Figures

Fig 1.1	Flowchart of the image stitching processes proposed in this thesis	3
Fig 2.1	(a) Original image, (b) barrel distortion, (c) pincushion distortion, and (d) combination of barrel and pincushion distortions	4
Fig 2.2	(a) The reference pattern (b) the reference image obtained from the camera.....	7
Fig 2.3	The reference images for camera calibration	7
Fig 2.4	The ordering rules for corners selection	8
Fig 2.5	(a) Radial component of distortion model, (b) tangential component of distortion model, and (c) complete distortion model.....	9
Fig 2.6	The estimation of the camera position (a) the world-centered view, (b) the camera-centered view	9
Fig 2.7	The original images (left), and the undistorted images (right).....	10
Fig 3.1	The results of feature extraction process for the source images (left images) and the target images (right images)	13
Fig 3.2	The results of feature matching process for the source images (left images) and the target images (right images)	17
Fig 4.1	The mapped source images before compensative processes	25
Fig 4.2	The mapped source images after compensative processes	26
Fig 4.3	Canvases V_{ct} (left), V_{cs} (middle) and V_{cb} (right).....	27
Fig 5.1	The combined region with different gray-level values in V_{cb}	29
Fig 5.2	Flowchart of the rectangular boundary determination for the source region	31
Fig 5.3	The boundary determination of V_{cb} (a) for Fig 5.1(a), and (b) for Fig 5.1(b)	31
Fig 5.4	(a) Random placement of blocks, (b) Neighboring blocks constrained by overlap, and (c) image quilting based on minimum error boundary cut	33

Fig 5.5	Source images (left images), target images(middle images), and the stitching results in overlap regions (right images).....	35
Fig 5.6	(a) The original image, (b) the image with object insertion, and (c) the stitching results in the inserted region.....	35
Fig 6.1	The minimum error boundary cut line in the overlap region of the combined region (left), and the combined image after region assignment (right)	38
Fig 6.2	The possible path region for (a) the vertical main cut line, and (b) the horizontal main cut line to do the edge detection	40
Fig 6.3	The image stitching without brightness compensation (left images), and with brightness compensation (right images).....	42
Fig 6.4	The example for the proposed stitching method (a) three canvas, and (b) the rectangular boundaries of each region in the combined region.....	44
Fig 6.5	(a) Traditional line-type optimal partition, (b) novel band-type optimal partition.....	45
Fig 6.6	(a) The four sub regions and start points for optimal partition method, and (b) four candidates of the main cut lines.....	46
Fig 6.7	Draw the candidates of main cut lines on (a) the mapped source image, (b) the target image, and (c) the averaged color difference on the overlap region. (d) The chosen one as the main cut line	46
Fig 6.8	The region assignment after the main cut line determination	47
Fig 6.9	(a) The six sub regions and start points for optimal partition method, and (b) six candidates of the first sub cut lines.....	48
Fig 6.10	Draw the candidates of first sub cut lines on (a) the mapped source image, (b) the target image, and (c) color difference on the overlap region. (d) The chosen ones as the first sub cut lines.....	48
Fig 6.11	The region assignment after the first sub cut lines determination.....	49

Fig 6.12 (a) The two sub regions and start points for optimal partition method, and (b) the second sub cut lines	50
Fig 6.13 The region assignment after the second sub cut lines determination	50
Fig 6.14 (a) Show the useless parts of cut lines and the undetermined border and (b) mark the combined region by all cut lines and boundaries of the overlap region	51
Fig 6.15 (a) The meaning of each pixel value and the examples that (b) and (c) the center marked pixels are not parts of border, (d) and (e) the center marked pixels are parts of border.....	52
Fig 6.16 The combined region with the border after border determination	52
Fig 6.17 The color transition from the mapped source image to the target image	53
Fig 6.18 The final stitching results after all the image stitching processes	53
Fig 7.1 The input images stitching in radial direction for the proposed image stitching process	55
Fig 7.2 The results of applying the proposed image stitching process	55
Fig 7.3 The input images stitching in counterclockwise direction for the proposed image stitching process	56
Fig 7.4 The results of applying the proposed image stitching process	56
Fig 7.5 The input images frame from video for the proposed image stitching process.....	57
Fig 7.6 The stitching results after combining the first twelve image frames.....	58
Fig 7.7 The stitching results after combining the thirteenth to the last image frame	59
Fig 7.8 The input images captured in 360 degrees for the proposed image stitching process.	60
Fig 7.9 The results of combing each image group by the proposed image stitching process..	61
Fig 7.10 The great color difference makes the borders obvious.....	62
Fig 7.11 The position mismatching cases that generate the discontinuous edges	63
Fig 7.12 The failed case of the proposed image stitching method (a) the source image, and (b) the target image	64

Index of Tables

Table 2.1 The intrinsic camera parameters and the reprojection error	8
Table 4.1 The number of trials N_{mg} and N_t	24

