

Contents

1	INTRODUCTION	1
1.1	Issues	3
1.2	Motivation	3
1.3	Problem Definition	4
1.4	Contributions of the Thesis	5
1.5	Organization of the thesis	5
2	RELATED WORK	6
2.1	Prototype based Approaches	7
2.2	Anthropometry-Model-Based Approaches	8
2.3	Deep Learning Based Approaches	9
2.4	Conclusion	9
3	FACIAL FEATURE POINTS (FFP) LOCALIZATION	10
3.1	Introduction	11
3.2	Preparation of Age Prototype Landmark Points Template	14
3.2.1	Age-Prototype of Age Group $[a - b]$	15
3.2.2	Perform Normalization of the Landmark Points to get Age-Prototype-Landmark-Points Template	18
3.3	The Methodology for Facial Feature Points (FFP) Localization	18
3.3.1	Select Eye Center and Mouth Mid Positions	20
3.3.2	Extract the Face	22
3.3.3	Fit Template Feature Points, and Localize the Facial Feature Points	24
3.4	Triangulation and Facial Parts Identification	27

3.5	Facial Parts Extraction	28
3.6	Comparisons of Localized and Manually Marked Feature Points in FG-NET Dataset Images	33
3.6.1	Similarity between Two Point Sets	34
3.7	Databases Used in the Experiments	35
3.7.1	FG-NET Aging Database	35
3.7.2	BioID Face Database	37
3.8	Result Comparisons of Facial Landmark Localization	37
3.9	Conclusion	41
4	A METHOD FOR IMAGE WARPING	42
4.1	Proposed Warping Method	46
4.1.1	Triangle to Triangle Mapping	48
4.1.2	Procedure $WarpObject(Obj_1, Obj_2)$	50
4.1.3	Procedure $MappTriangle(T_1, T_2)$	50
4.1.4	Procedure $Subtri(T)$	52
4.1.5	Pixel Mapping $PixelMap(T_1, T_2)$	53
4.1.6	Transfer pixel from c_1 to c_2 : $PixelTransfer(c_1, c_2)$	54
4.1.7	Nearest Pixel Coordinates: $NearestPixels(p, q)$	55
4.2	Database used for Experiments of Image Warping	55
4.3	Experimental Results of Image Warping	56
4.4	Conclusion	59
5	PREDICTION OF OUTPUT IMAGE USING MORPHING	61
5.1	Related Works of Morphing	62
5.2	A Morphing Based Technique to Predict Older Face Images of a Child	64
5.2.1	Take inputs of source and target images	66
5.2.2	Preprocess Inputs	66
5.2.3	Find Detected Face and Feature Points of Source (Shape)	67
5.2.4	Find Detected Face and Feature Points of Target (Shape)	67
5.2.5	Find Intermediate Feature Points (Shape)	67
5.2.6	Find Warped Image of Source and Target	68

<i>CONTENTS</i>	ix
5.2.7 Find Morph images	69
5.3 Find Predicted Face Image of Age k of a Child using Morphing . . .	70
5.4 Prediction of Older Images for which Age Difference of Source and Target is High	71
5.5 Conclusion	72
6 EXPERIMENTS AND EVALUATION	77
6.1 Evaluation Techniques	77
6.1.1 Human Feedback Score for Comparing two Face Images . . .	78
6.1.2 Face Recognition Tool using OpenCV and Python	78
6.2 Evaluation of the Predicted Future Appearance of a Child's Face Image	80
6.2.1 Performance Comparison of with Previous Works	80
7 CONCLUSION	85
7.1 Directions for Future Works	86
Bibliography	97
List of Publications	97