

TABLE OF CONTENTS

CHAPTER 1	1
Introduction.....	1
1.1 Objective	2
1.2 Related Work	4
1.2.1 Methods of 3D modeling.....	4
1.2.2 Survey of 3D caricature generating system.....	6
1.3 Overview	7
CHAPTER 2	9
Facial model definition and feature extraction.....	9
2.1 Facial Feature Nodes	9
2.1.1 Group hierarchy	10
2.1.2 Types of feature nodes.....	12
2.2 Facial feature extraction	14
2.2.1 Limitations of Active Contour Model [10] on facial feature extraction	14
2.2.2 Active Appearance Model	15
2.2.3 Results.....	19
CHAPTER 3	27
Disparity and depth map computation.....	27
3.1 Depth map recovery by stereo vision	27
3.2 Disparity computation	29
3.3 Interpolation and smoothing.....	33

CHAPTER 4	37
Facial feature exaggeration and caricature generation	37
4.1 Average data computation	37
4.2 Facial feature exaggeration.....	40
4.3 Image metamorphosis.....	48
CHAPTER 5	51
3D Caricature facial model generation	51
5.1 3D mesh generation	51
5.2 Generation of MPEG-4 compatible facial model.....	54
5.3 Illustrations	59
5.4 A sample 3D head.....	65
CHAPTER 6	67
Conclusions.....	67
References.....	69

LIST OF FIGURES

1.1	ILLUSTRATION OF MR. KATSUHIKO YOSHIDA.....	2
1.2	A PERSONAL PORTRAITURE WITH THEME SERVICE	2
1.3	A RANGE IMAGE AND ITS TEXTURE MAP	5
1.4	FRONT VIEW SYNTHESIS BY LEFT AND RIGHT VIEW.	5
1.5	A STEREO PAIR OF A FACE.	6
1.6	THE DEPTH MAP AND THE INITIAL MESH A STEREO PAIR OF A FACE.....	6
1.7	(A) A FACE MODEL WITH OLD LOOK GENERATED BY MODULATING PARAMETERS. (B) AN INPUT FACE ACQUIRED BY RANGE SCANNER (C)CORRESPONDING FACIAL MODEL GENERATED BY 3D PICASSO.	7
1.8	A OVERVIEW OF THE PROPOSED 3D CARICATURE SYSTEM.	8
2.1	MPEG-4 FACE DEFINITION AND FACE ANIMATION PARAMETERS	9
2.2	(A) THE 8 FACIAL GROUPS (B) THE RELATIONSHIP BETWEEN FACIAL GROUPS.....	10
2.3	SPATIAL RELATIONSHIP AMONG THE DIFFERENT GROUPS	11
2.4	(A) THE MASTER NODE (B) THE CALIBRATION NODE.....	12
2.5	FEATURE NODES FOR FACIAL DEFINITION.....	13
2.6	IMM DATABASE IMAGES WITH DIFFERENT TITLE POSES, LIGHT CONDITIONS, AND COURTENANCES OF EACH PERSON.....	17
2.7	TRAINING DATA WITH 92 POINTS ANNOTATED	17
2.8	MODEL OF SHAPE.	18
2.9	MODEL OF TEXTURE.....	18
2.10	AAM SEARCH PROCESS.	18
2.11	TWO EXAMPLES AFTER SEARCHING.	19
2.12	SOME OTHER RESULTS.	20
2.13–2.15	SEARCH RESULTS FROM DIFFERENT INITIAL POSITIONS.....	20-21
2.16	SEARCH RESULTS OF IMAGES UNDER NORMAL CONDITIONS.....	22
2.17-18	DIFFERENT SIZE AND INITIAL POSITION OF MEAN FACE AND ITS RESULT	23-24
2.19	EXAMPLES OF TRAINING SET FROM THE FACE DATABASE WE MAINTAIN.....	25
2.20	FEATURE EXTRACTION RESULTS OBTAINED BY AAM.....	26
3.1	A PARALLEL IMAGE PAIR AFTER UNDISTORTION AND RECTIFICATION	28
3.2	RELATION BETWEEN DEPTH AND DISPARITY	29
3.3	A DISPARITY MAP COMPUTED BY 7x7 WINDOW AND ITS RESULT AFTER CORRECTION	30

3.4	DEPTH MAP OBTAINED BY DIFFERENT WINDOW SIZE	31
3.5	RESULT OF MULTI-LAYER ALGORITHM (LEFT) AND ITS HISTOGRAM	31
3.6	(B) PROFILE OF THE RED LINE IN (A) (C) PROFILE OF THE BLUE LINE IN (A).....	32
3.7	FACES IN AN IMAGE PAIR ARE SEPARATED INTO SMALL REGIONS	33
3.8	DISPARITY MAP OBTAINED BY THE MODIFIED CORRELATION ALGORITHM.....	33
3.9	(A)(B) DEPTH MAPS AFTER INTERPOLATION (C)(D) DEPTH MAPS AFTER SMOOTHING	35
3.10	IMAGES WITH DIFFERENT VIEW AND THEIR CORRESPONDING DISPARITY MAP	36
4.1	THE ORIGIN OF FACIAL COORDINATE WE DEFINE.	38
4.2	ILLUSTRATION OF THE NORMALIZATION EQUATION	40
4.3	LINEAR MODEL FOR COMPUTING THE RATIO OF EXAGGERATION OUT OF THE NORMAL RANGE	41
4.4	VIRTUAL POINTS INTERPOLATED FROM FEATURE NODES FOR THE REFERENCE OF DEPTH	44
4.5	(A) THE EXAGGERATED SHAPE OF THE EYE IS OUT OF THE FACE CONTOUR WHEN A LARGE EXAGGERATION RATE IS DECIDED. (B) PARTIALLY MOVE THE FACE CONTOUR TO AVOID COLLISION.....	46
4.6	AFFECTED BY ALL THE LINE PAIRS, PIXEL X IN THE DESTINATION IMAGE IS MAPPED TO X' IN THE SOURCE IMAGE.....	49
4.7	(A) SUBJECT (B,D) DIFFERENT ARTISTS' WORK (C,E) CARICATURES WITH (B,D)'S STYLE.....	50
5.1	ILLUSTRATION OF $L_{\text{FRONTVIEW}}$ AND L_{PROFILE}	52
5.2	A PIXEL RENDERING EXAMPLE GENERATED BY OpenGL	53
5.3	MESH ILLUSTRATED IN FIG. 5-2 OVERLAID WITH CARICATURE DRAWING	53
5.4	FACE MESH DIVIDED INTO SUB-SURFACES BY TRIANGLES	55
5.5	SPLIT TRIANGLES INTO 3 PARTS WITH EQUAL AREA BASED ON ITS CENTER OF GRAVITY	55
5.6	SPLIT TRIANGLES INTO 6 PARTS WITH EQUAL AREA BASED ON ITS CENTER OF GRAVITY.	56
5.7	SPLIT OCCURRING AT ONE OF TWO NEIGHBOR TRIANGLES WILL LEAD DISCONTINUITY AT POINT P	57
5.8	(A) THE SHAPES ARE SHARP NEAR THE FEATURE POINTS (B) DISCONTINUITY OF THE SURFACE	57
5.9	UPPER - SPLIT TRIANGLES INTO FIX NUMBER OF SUB-TRIANGLES WITH REGULAR SHAPES LOWER - ITS CAPABILITY OF RENDERING SURFACE.....	58
5.10	DIFFERENT ARTIST'S STYLES BY REPLACING SOURCE DRAWINGS	59

5.11-5.15	UPPER - 3D FACE MESH AND NON-TEXTURED MODEL LOWER - MODEL TEXTURED WITH VARIOUS STYLE OF CARICATURES.....	60-64
5.16	INTEGRATED HEAD MODEL	65
5.17	(A) SEED CROPPED FROM CARICATURE (B) TEXTURE SYNTHESIS RESULT (C) TEXTURE AFTER RELOCATED COORDINATES	66
5.18	A COMPLETE HEAD TEXTURED WITH TWO DIFFERENT STYLES OF CARICATURES	66

LIST OF TABLES

2.1	STRUCTURE AND HIERARCHY OF THE FACE COMPONENTS.....	11
4.1	STATISTICS DATA OF E_1	42
4.2	CONTRIBUTION OF E_2 IN SIZE EXAGGERATION	43
4.3	COLLISION AS A RESULT OF RELATIVE POSITION EXAGGERATION.....	47
4.4	COLLISION AS A RESULT OF SIZE EXAGGERATION	47