

**/MAGNIFICATION OF BIT MAP IMAGES
WITH INTELLIGENT SMOOTHING OF EDGES/**

by

CHARLES ROBERT SCHAEFER

B. S. E. E., Purdue University, 1966

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Computer Science

**KANSAS STATE UNIVERSITY
Manhattan, Kansas**

1986

Approved by:

William Hankley
Major Professor

LD
2668
.24
1986
532
c. 2

111202 664102

TABLE OF CONTENTS

Report Cover	
Table of Contents	i
List of Figures	ii through iv
ACKNOWLEDGEMENTS	v
INTRODUCTION	I-1 through I-8
The Vector-Raster Duality	I-1
Design Objectives	I-3
The Successive Contouring Procedure	I-4
Review of Related Literature	I-6
METHODOLOGY	M-9 through M-25
Conventional Low-Pass Filtering	M-9
An Empirical Method would be Better	M-12
Bullseye Scanning	M-16
Discussion of Details	M-20
DESCRIPTION of Program	D-26 through D-31
EVALUATION of Performance	E-32 through E-43
CONCLUSIONS	C-44 through C-51
Edge Smoothness	C-44
Speed and Efficiency	C-46
Shapes and proportions	C-48
Potential Applications	C-49
REFERENCES and BIBLIOGRAPHY	52 through 55
APPENDIX 1	GROW Program Source
APPENDIX 2	NAPLPS Tutorial

LIST OF FIGURES AND TABLES

- Figure 1 Low-Pass Filtering Page M-10
Printed on the laser printer at 150 dots per inch resolution from an 80 by 48 bit map magnified to 8 times its original dimensions and 64 times its original area.
- Figure 2 Surface Function Page M-11
Printed by Daisy wheel printer as text.
- Figure 3 Elementary Contour Shapes Page M-13
Printed on the Dot Matrix printer at 68 dots per inch from four individual 40 by 24 bit maps. Magnification was 2X.
- Figure 4 Positioning Output Pixels Page M-17
Printed on the laser printer at 300 dots per inch from a 52 X 52 dot original. The magnification was 8X. Characters in the original image were 7 or 8 dots high.
- Figure 5 Pixel Translations Page M-19
Printed on the dot matrix printer at 68 dots per inch from two 80 X 280 dot originals. No magnification was used.
- Figure 6 Pixel Image Transformations RND Page M-21
Printed on the laser printer at 300 dots per inch from three originals. The first was magnified by 4X, the second by 2X, and the third by 4X. Each little circle was a 5 X 5 cell of pixels in the original.
- Figure 7 Pixel Image Transformations SQ Page M-21
Printed on the laser printer at 300 dots per inch from three originals. The first was magnified by 4X, the second by 2X, and the third by 4X. Each little square was a 3 X 3 cell of pixels in the original.

- Figure 8 The Bullseye Page D-28
- Printed on the dot matrix printer at 68 dots per inch from an 80 X 80 dot original. No magnification was used.
- Figure 9 Successive Contouring (crude) Page E-34
- Printed on the dot matrix printer at 23 dots per inch. Each dot is produced as a small bead-shaped pattern downloaded into the printer as a text character. The magnifications shown are 2X, 4X and 8X.
- Figure 10 Successive Contouring (fancy) Page E-35
- Printed on the dot matrix printer in the same manner as Figure 9. Magnifications are 2X and 4X. The small character at the base line was added in a second pass by the laser printer. It is identical to the 4X magnified image, but printed at 300 dots per inch.
- Figure 11 Lines of various slopes Page E-36
- Printed on the dot matrix printer in the same manner as Figures 9 and 10.
- Figure 12 Arbitrary Curves Page E-37
- Printed on the laser printer at 150 dots per inch and raw text input form. The magnification is 8X.
- Figure 13 Three Kitties Page E-38
- The first and second kitty were printed on the dot matrix printer at 23 and 68 dots per inch, with a 2X magnification factor. The third kitty was printed from the same original on the laser printer at 150 dots per inch, with 8X magnification.
- Figure 14 Text Banner Enhancement Page E-39
- The input was obtained from a banner program with about 12 dots per inch. This was doubled three times to a density of 75 dots per inch, on the laser printer.

Figure 15 Music Notation Page E-40

The first two parts were done on the dot matrix printer at 23 and 68 dots per inch. The third was done on the laser printer at 150 dots per inch, with a magnification of 8X.

Figure 16 Circles Page E-41

Illustrates both densification and magnification. Scaling is applied to illustrate both densification and magnification. Upper row pixel densities are doubled at each magnification step. Lower row pixel densities remain the same.

1X at 75dpi 2X at 150dpi 4X at 300dpi

1X 2X 4X 8X all at 150dpi

Figure 17 Anomalies and extremes Page E-42

Each input pixel pattern is diagrammed above its resulting output. All parts are printed on dot matrix printer at about 136 dots per inch. Magnification factors are 32X (part A), 16X (PartB), and 8X (Part C).

Figure 18 Grow vs Enlargement Page E-43

The first enlargement is made directly by printing the 136 dpi original at 23 dpi. Then the original goes through 3 passes of doubling to 8X and the result is printed at 68 dpi for a 16X magnification. A true 16X magnification printed at 136 dpi would look exactly like this, except in the fineness of the tiny sawtooth edges.

Figure 19 Data Flow Diagram Appendix 1 Page 1

Produced by conventional text processing tools on the laser printer.