

BE 3600 BIOMEDICAL INSTRUMENTATION (LAB) -

Experiment 12: Image Analysis on a Computer

OBJECTIVE: Learn the basic principles of analysis of images for extraction of features.

BACKGROUND ON COMPUTER TOMOGRAPHY

Read Chapter 14 of "Medical Physics and Biomedical Engineering" by B.H. Brown et al. A handout will be provided in advance.

Some additional 3x3 filters are also given below:

Laplacian (Measures the rate of change)

-1	-2	-1
-2	+12	-2
-1	-2	-1

Vertical Gradient (Detects horizontal edges)

+1	+2	+1
0	0	0
-1	-2	-1

Horizontal Gradient (Detects vertical edges)

-1	0	+1
-2	0	+2
-1	0	+1

Mean (Smoothing operator)

$1/9$	$1/9$	$1/9$
$1/9$	$1/9$	$1/9$
$1/9$	$1/9$	$1/9$

Median

$a_{1,1}$	$a_{1,2}$	$a_{1,3}$
$a_{2,1}$	$a_{2,2}$	$a_{2,3}$
$a_{3,1}$	$a_{3,2}$	$a_{3,3}$

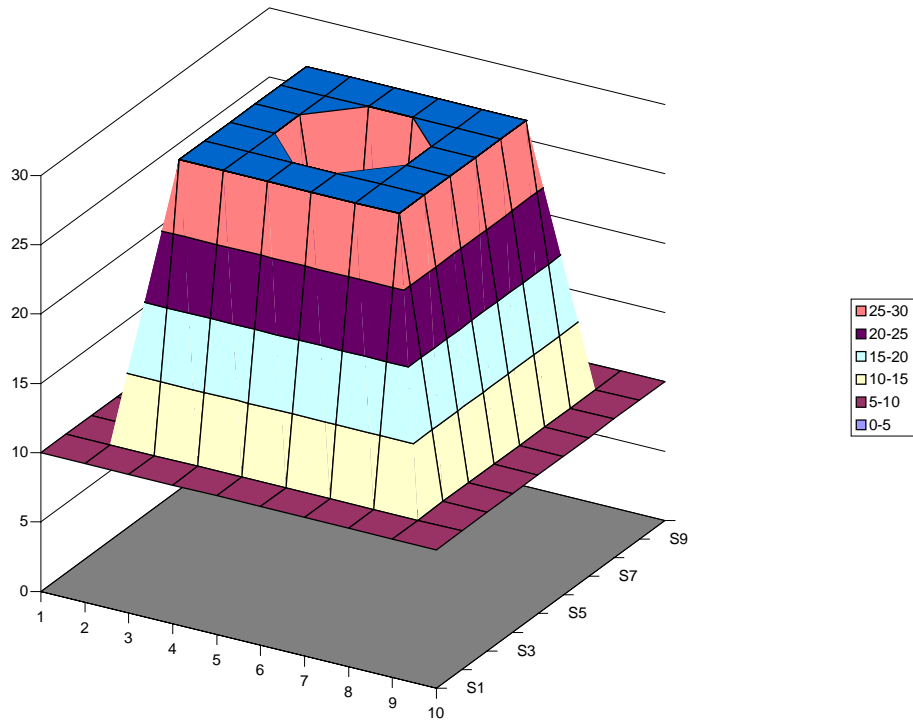
where the value of the image pixel which is at the center of the 3x3 mask is calculated as the median value of the pixel itself and its 8 neighbors.

EXPERIMENT

1. Assume that the object shown below was imaged:

10	10	10	10	10	10	10	10	10	10
10	10	10	10	10	10	10	10	10	10
10	10	30	30	30	30	30	30	10	10
10	10	30	30	30	30	30	30	10	10
10	10	30	30	10	10	30	30	10	10
10	10	30	30	10	10	30	30	10	10
10	10	30	30	30	30	30	30	10	10
10	10	30	30	30	30	30	30	10	10
10	10	10	10	10	10	10	10	10	10
10	10	10	10	10	10	10	10	10	10

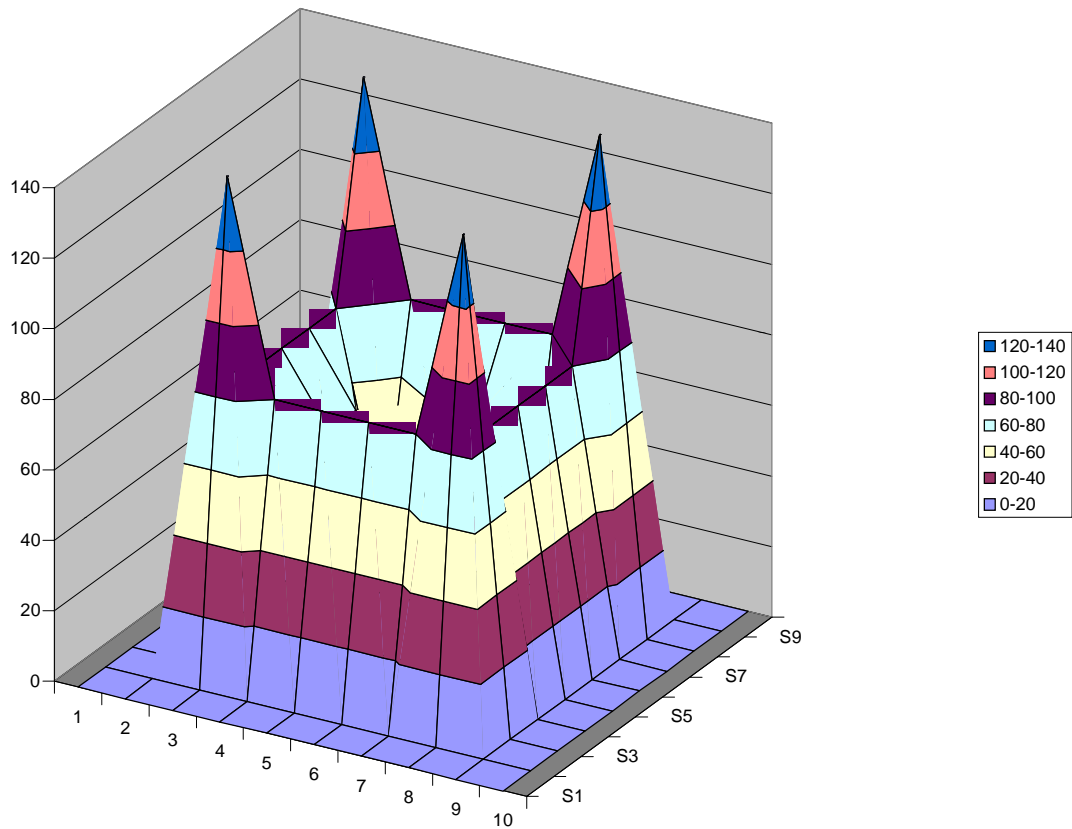
RAW IMAGE



2. Application of the Laplacian Operator would yield the following:

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	140	80	80	80	80	140	0	0
0	0	80	20	60	60	20	80	0	0
0	0	80	60	0	0	60	80	0	0
0	0	80	60	0	0	60	80	0	0
0	0	80	20	60	60	20	80	0	0
0	0	140	80	80	80	80	140	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

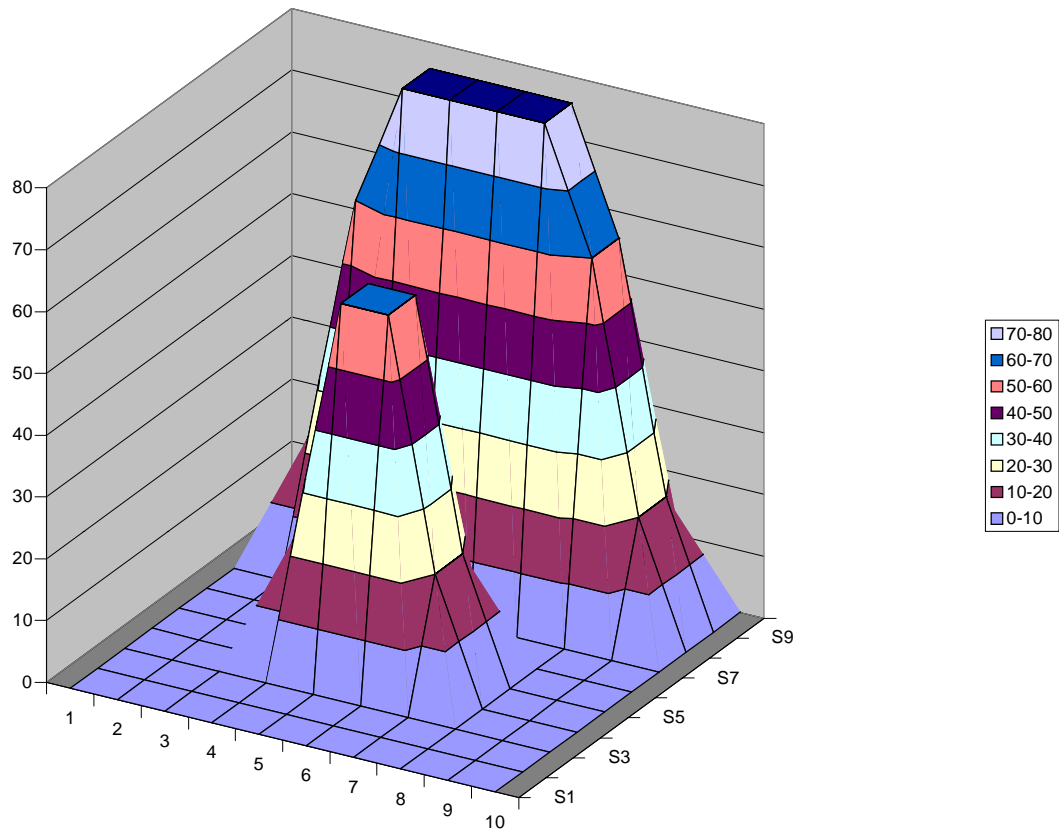
LAPLACIAN OPERATOR



3. Application of the Vertical Gradient Detector would yield the following:

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	20	60	60	20	0	0	0
0	0	0	20	60	60	20	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	20	60	80	80	80	80	60	20	0
0	20	60	80	80	80	80	60	20	0
0	0	0	0	0	0	0	0	0	0

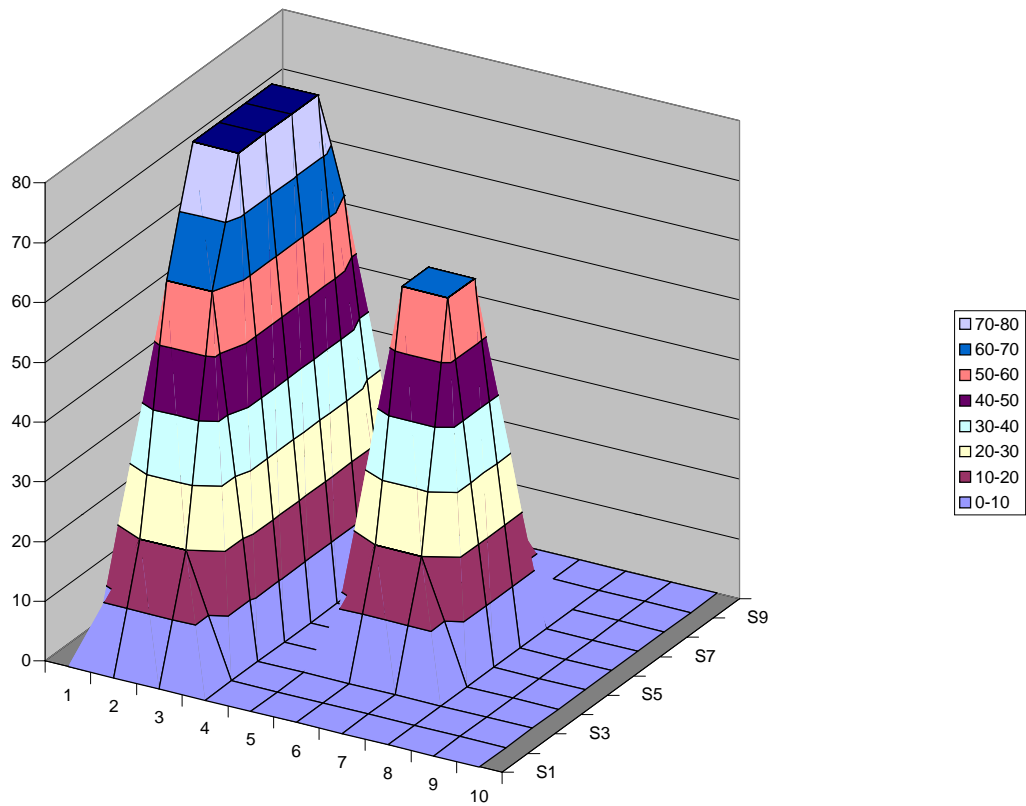
VERTICAL GRADIENT DETECTION



4. Application of the Horizontal Gradient Detector would yield the following:

0	0	0	0	0	0	0	0	0	0
0	20	20	0	0	0	0	0	0	0
0	60	60	0	0	0	0	0	0	0
0	80	80	0	0	20	20	0	0	0
0	80	80	0	0	60	60	0	0	0
0	80	80	0	0	60	60	0	0	0
0	80	80	0	0	20	20	0	0	0
0	60	60	0	0	0	0	0	0	0
0	20	20	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

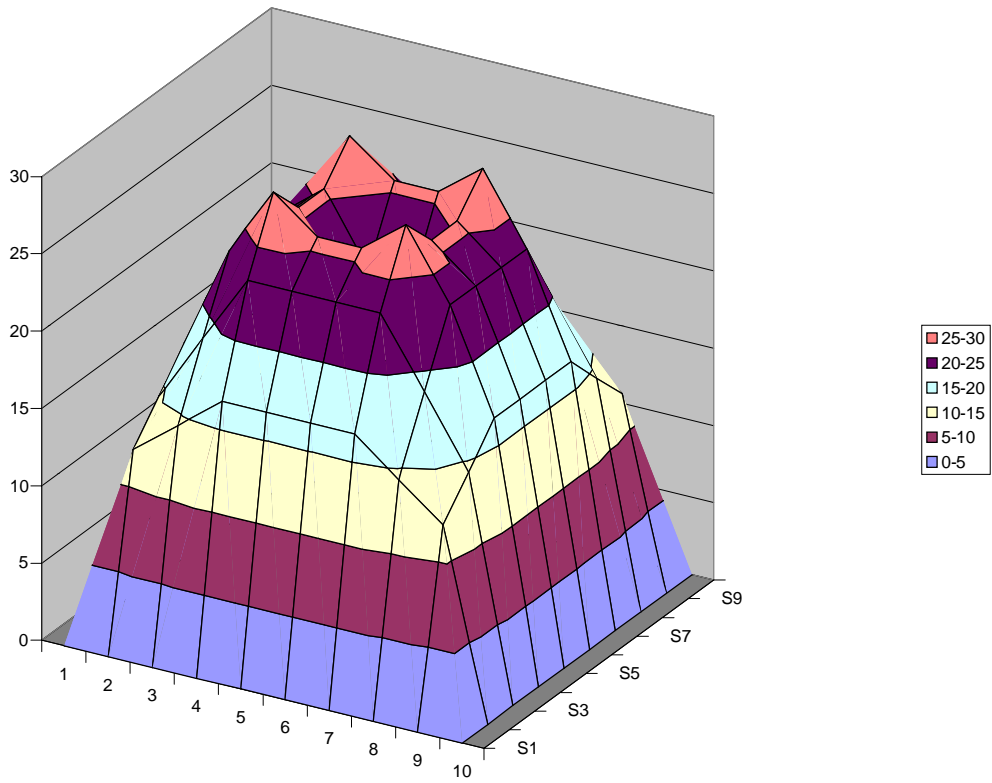
HORIZONTAL GRADIENT DETECTION



5. Application of the Mean Filter would yield the following:

0	0	0	0	0	0	0	0	0	0
0	12.2	14.4	16.7	16.7	16.7	16.7	14.4	12.2	0
0	14.4	18.9	23.3	23.3	23.3	23.3	18.9	14.4	0
0	16.7	23.3	27.8	25.6	25.6	27.8	23.3	16.7	0
0	16.7	23.3	25.6	21.1	21.1	25.6	23.3	16.7	0
0	16.7	23.3	25.6	21.1	21.1	25.6	23.3	16.7	0
0	16.7	23.3	27.8	25.6	25.6	27.8	23.3	16.7	0
0	14.4	18.9	23.3	23.3	23.3	23.3	18.9	14.4	0
0	12.2	14.4	16.7	16.7	16.7	16.7	14.4	12.2	0
0	0	0	0	0	0	0	0	0	0

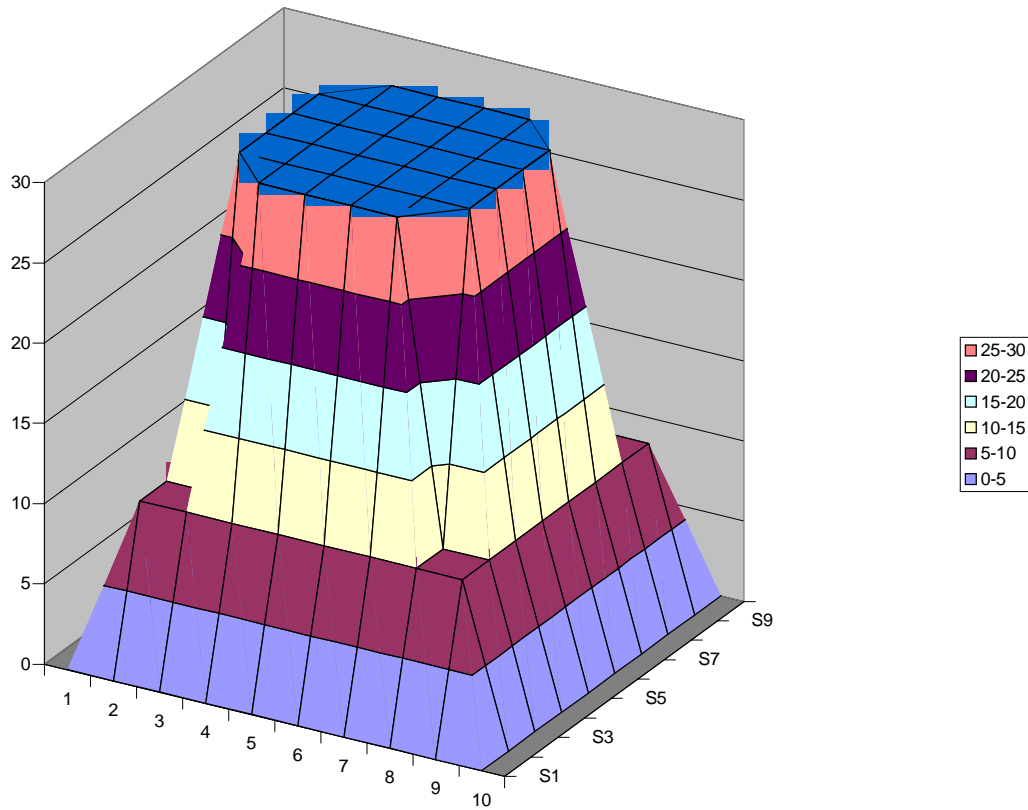
MEAN FILTER APPLIED



6. Application of the Median Filter would yield the following:

0	0	0	0	0	0	0	0	0	0
0	10	10	10	10	10	10	10	10	0
0	10	10	30	30	30	30	10	10	0
0	10	30	30	30	30	30	30	10	0
0	10	30	30	30	30	30	30	10	0
0	10	30	30	30	30	30	30	10	0
0	10	30	30	30	30	30	30	10	0
0	10	10	30	30	30	30	10	10	0
0	10	10	10	10	10	10	10	10	0
0	0	0	0	0	0	0	0	0	0

MEDIAN FILTER APPLIED



REPORT:

1. Using your student ID number, add noise to the image shown in step 1 of the experiment section. For example, if your student ID is 234-56-7890, then the noisy version of the raw image will be as follows:

12	13	14	15	16	17	18	19	10	12
13	14	15	16	17	18	19	10	12	13
14	15	36	37	38	39	30	32	13	14
15	16	37	38	39	30	32	33	14	15
16	17	38	39	10	12	33	34	15	16
17	18	39	30	12	13	34	35	16	17
18	19	30	32	33	34	35	36	17	18
19	10	32	33	34	35	36	37	18	19
10	12	13	14	15	16	17	18	19	10
12	13	14	15	16	17	18	19	10	12

2. Using the table below, and the last digit of your ID number, determine the 3x3 filter to use:

LAST DIGIT	0 or 1	2 or 3	4 or 5	6 or 7	8 or 9
USE FILTER	LAPLACIAN	VERTICAL GRADIENT	HORIZONTAL GRADIENT	MEAN	MEDIAN

Tabulate and plot your raw data as well as the processed data.

3. Comment how your filter changed your image. Did the noise increase or decrease?
4. Why are the images shown on sections 3 and 4 of experiment not symmetric?
5. How are the values of the 3x3 masks chosen?
6. Median filter used in the section 6 of the experiment caused the center of object to disappear. When would be a good time to use the median filter?