Go Reconfigure

By Dragos Popescu

FPGA's Are Everywhere

- Wireless Networks
  - Base stations
    - Pre-distortion
    - Baseband functionality
  - 802.16 - UWB
- Wired Networks
  - Serial backplanes
  - Line card solutions
    - Metro/Edge Routers
    - Edge Access
      - CMTS, DSLAMs
    - IP Routers
- Storage
  - Fabric Attached Storage
    - NAS and SANs

- Consumer
  - Digital Displays
  - Handsets
  - Home Networking
- Automotive Telematics
- Industrial
  - Medical Imaging - Ultrasound
  - Industrial Automation
- Military and Surveillance
  - Transformational Communications
- Next Generation Broadband
  - FTTH, VDSL, SHDSL
- Video Broadcast (Studio)

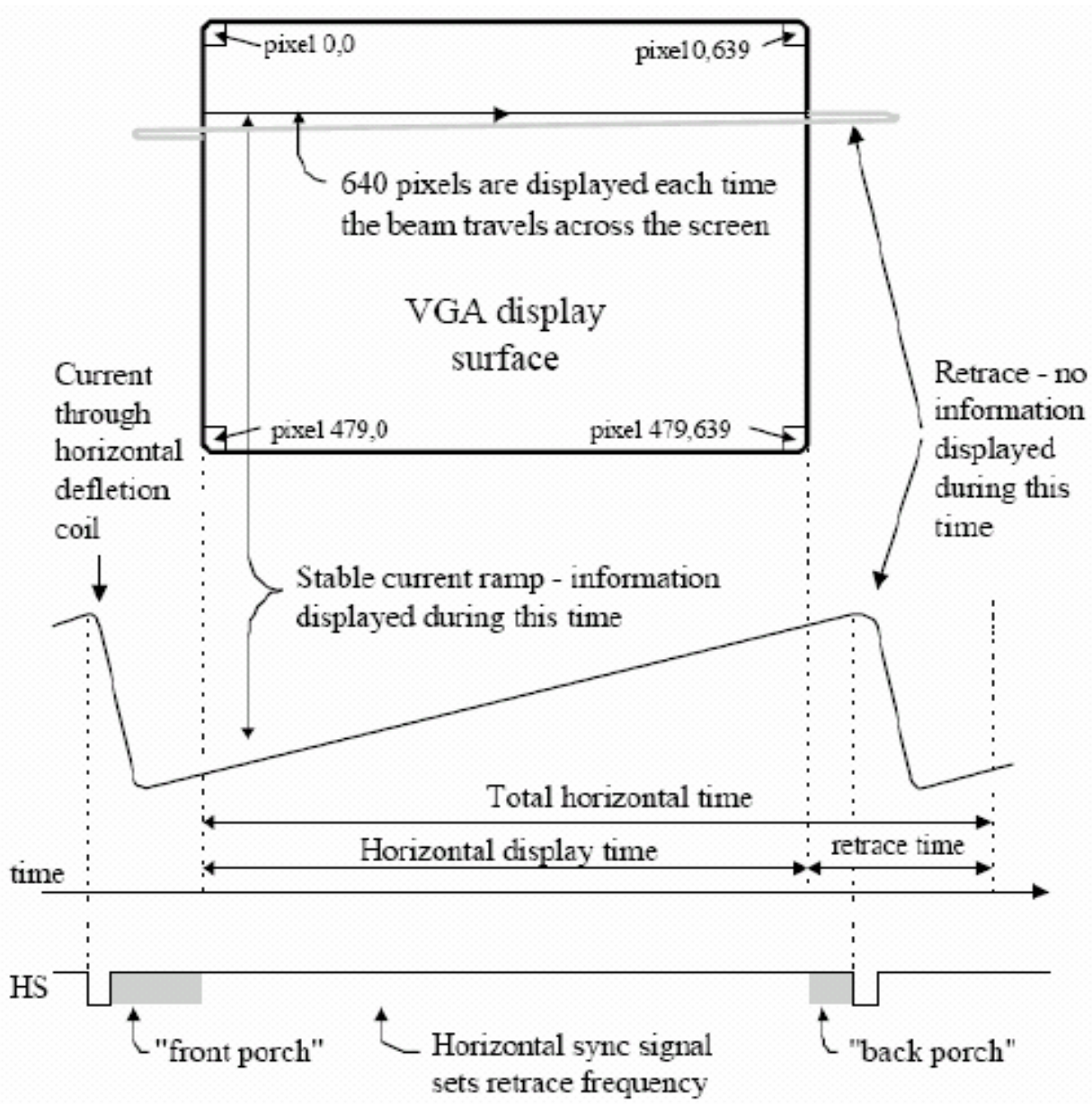
Same device – more functions

- VGA Controller
- PS/2 Controller
- Chess game
- Windowing Operators

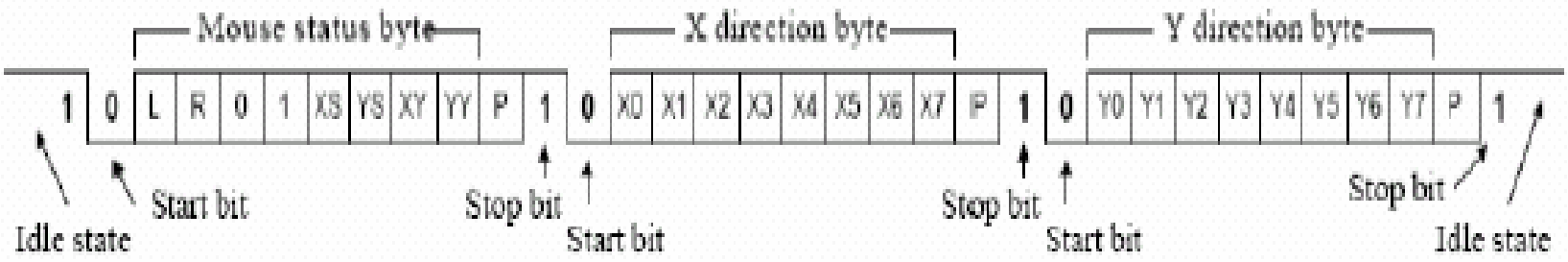
  Rank Order Filter
  Morphological Operators
  Convolution

Incoming:

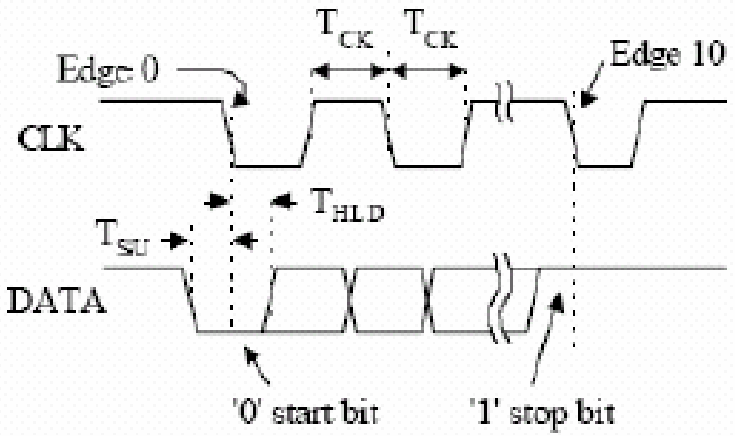
- 10Base-T Controller
- USB Interface
- Webcam Controller


pixel 0,0
pixel0,639
640 pixels are displayed each time the beam travels across the screen
VGA display surface
pixel 479,0
pixel 479,639
Current through horizontal defletion coil
Retrace - no information displayed during this time
Stable current ramp - information displayed during this time
Total horizontal time
Horizontal display time
retrace time
time
HS
"front porch"
Horizontal sync signal sets retrace frequency
"back porch"

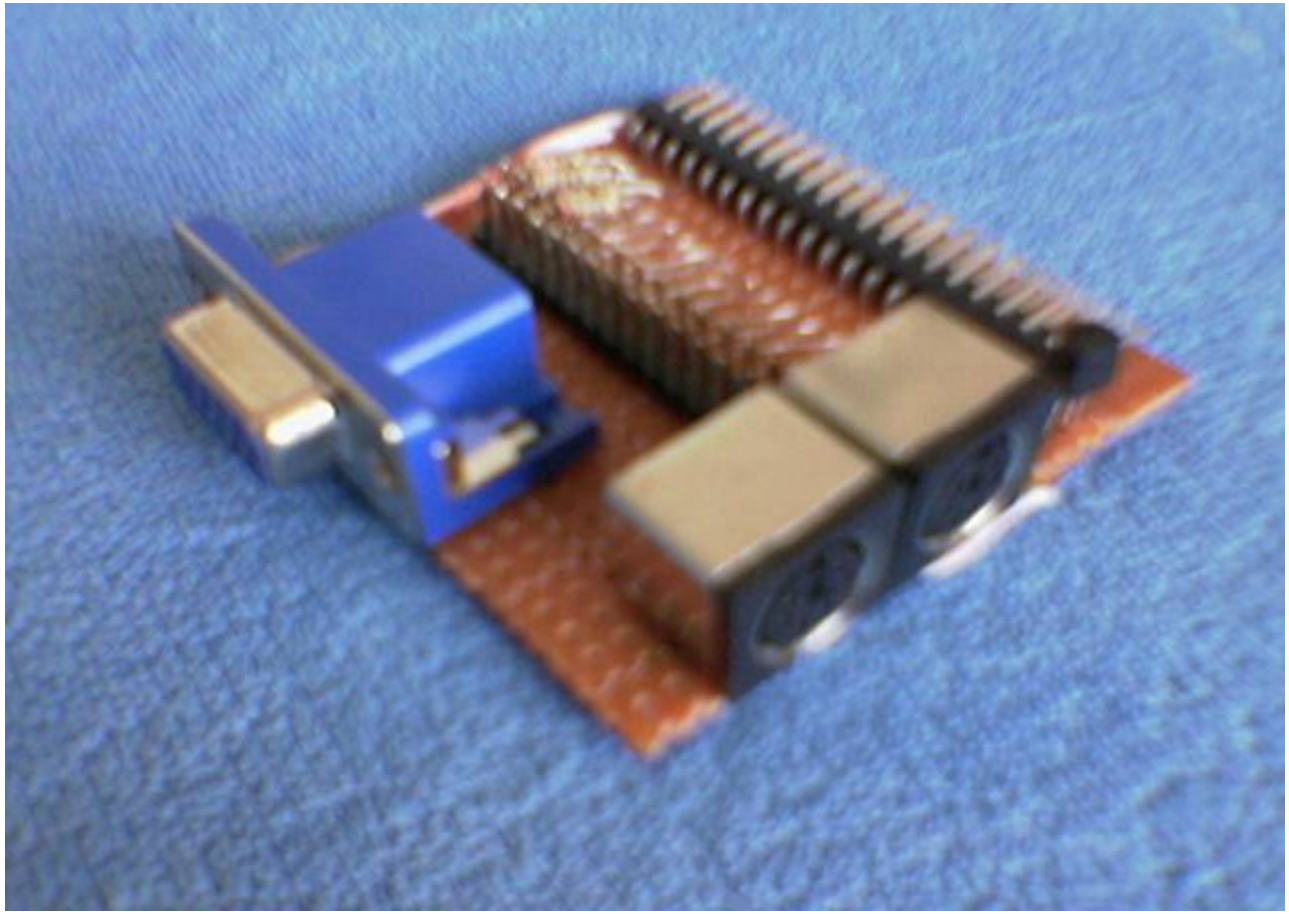
```
module VGATestTop(clk, hsync, vsync, r1, r0, g1, g0, b1, b0);
	input clk;

	output hsync;
	output vsync;
	output r1, r0, g1, g0, b1, b0;
	wire r1, r0, g1, g0, b1, b0;

	wire active;
	wire [11:0] x;
	wire [11:0] y;

	VGATimer #(800,64,120,56, 600,23,6,37, 1) timer (clk, hsync, vsync, active, x, y);

	assign r1 = active&&(~(x[0]^y[0]));
	assign r0 = active&&(~(x[1]^y[1]));
	assign g1 = active&&(~(x[2]^y[2]));
	assign g0 = active&&(~(x[3]^y[3]));
	assign b1 = active&&(~(x[4]^y[4]));
	assign b0 = active&&(~(x[5]^y[5]));

endmodule
```



Symbol	Parameter	Min	Max
T_{CK}	Clock time	30us	50us
T_{SU}	Data-to-clock setup time	5us	25us
T_{HLD}	Clock-to-data hold time	5us	25us

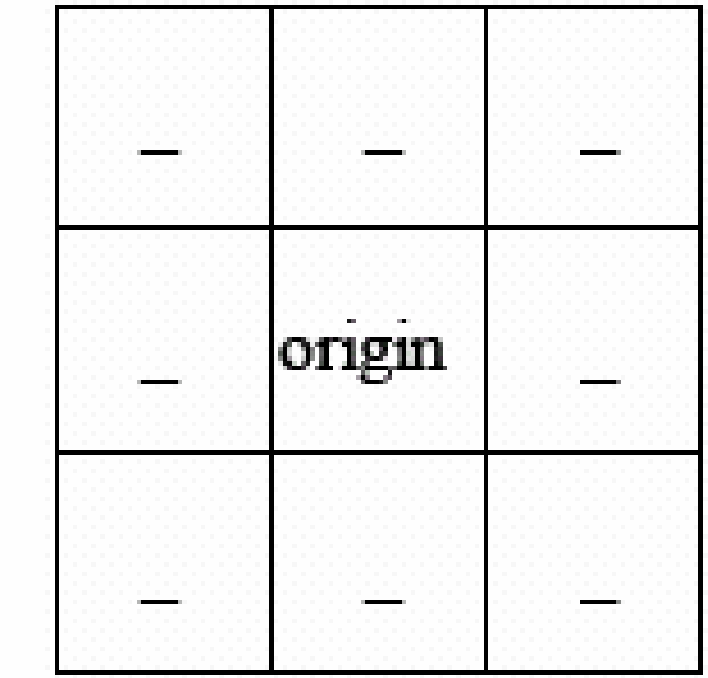


VGA & PS/2 Ports




00:01:09
00:00:15
FPGA Chess Demo
by Dragos Popescu

Introduction to Windowing Operators

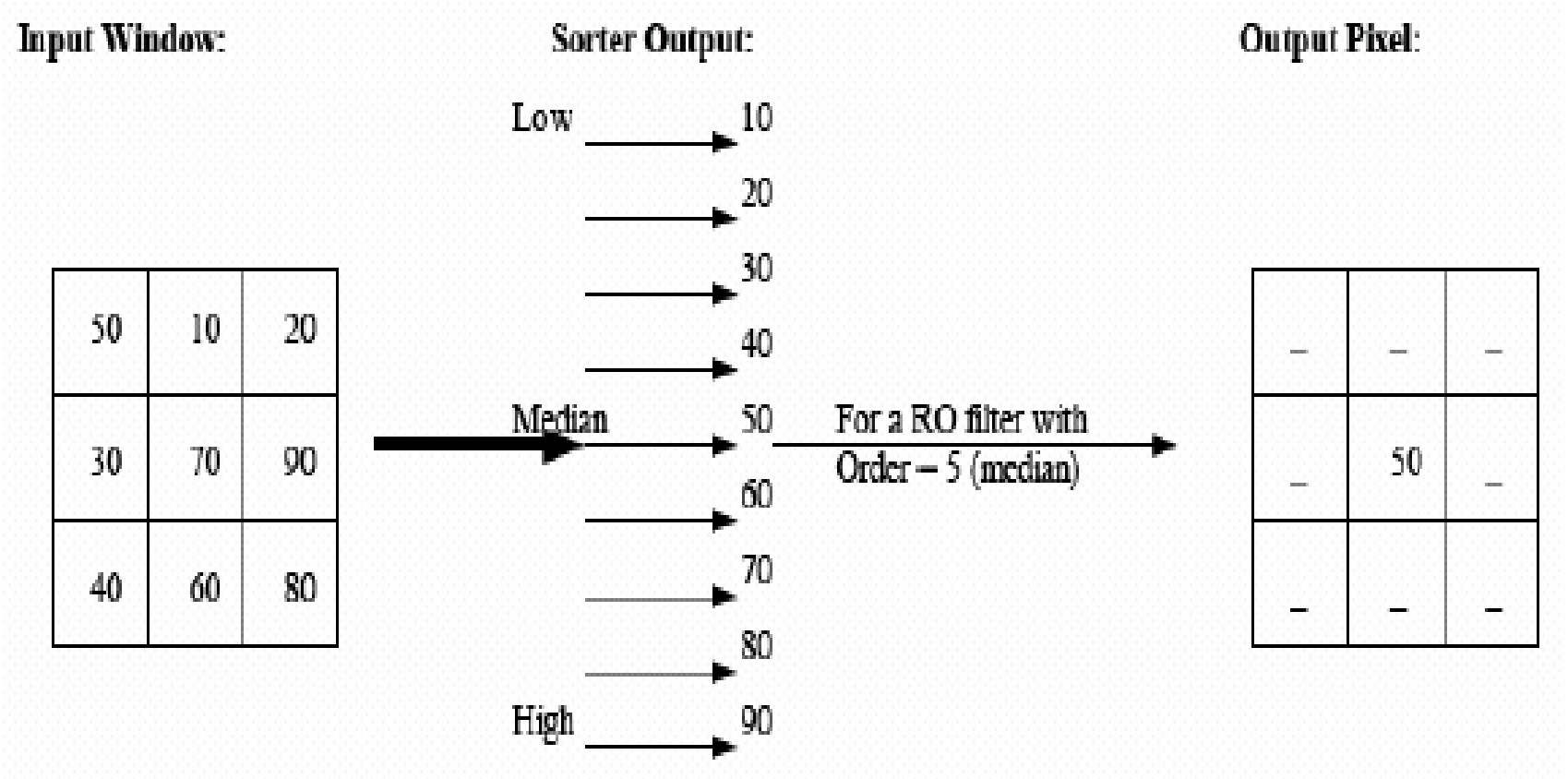


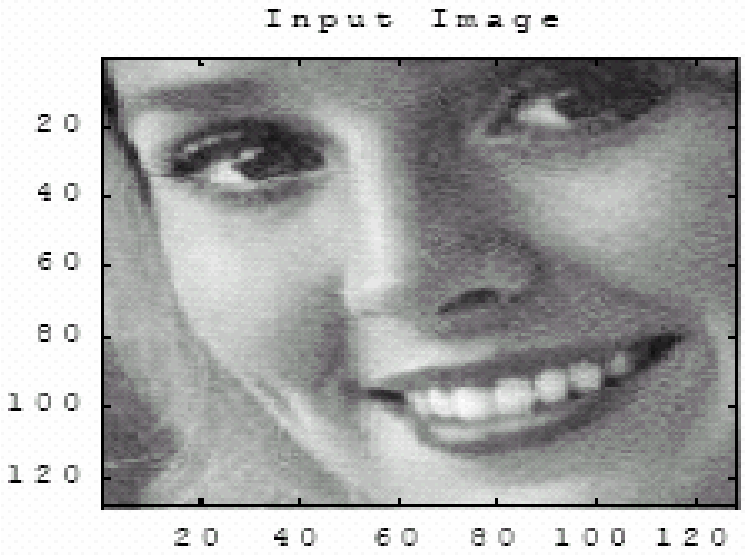
Pixel Window and Origin

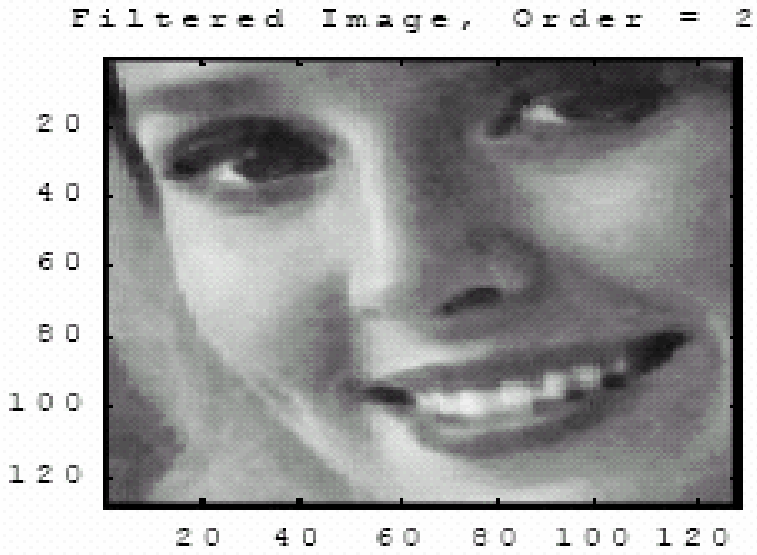
The Algorithms

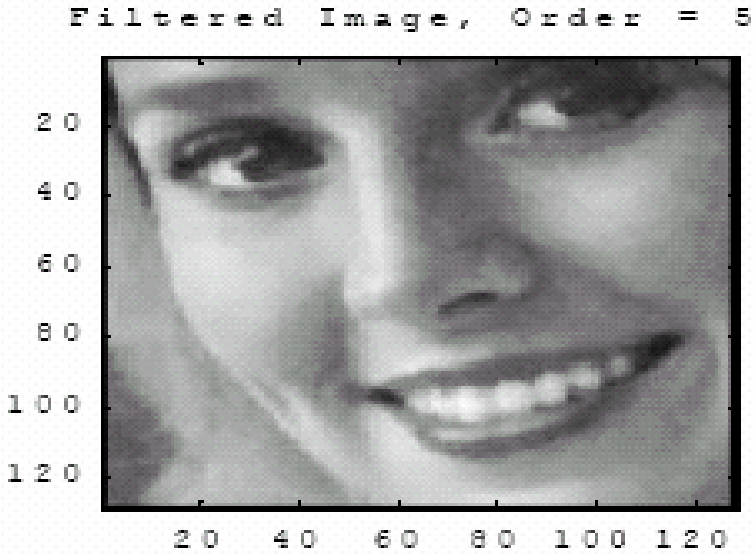
- **Rank Order Filter**
- **Morphological Operators**
- **Convolution**

Rank Order Filter



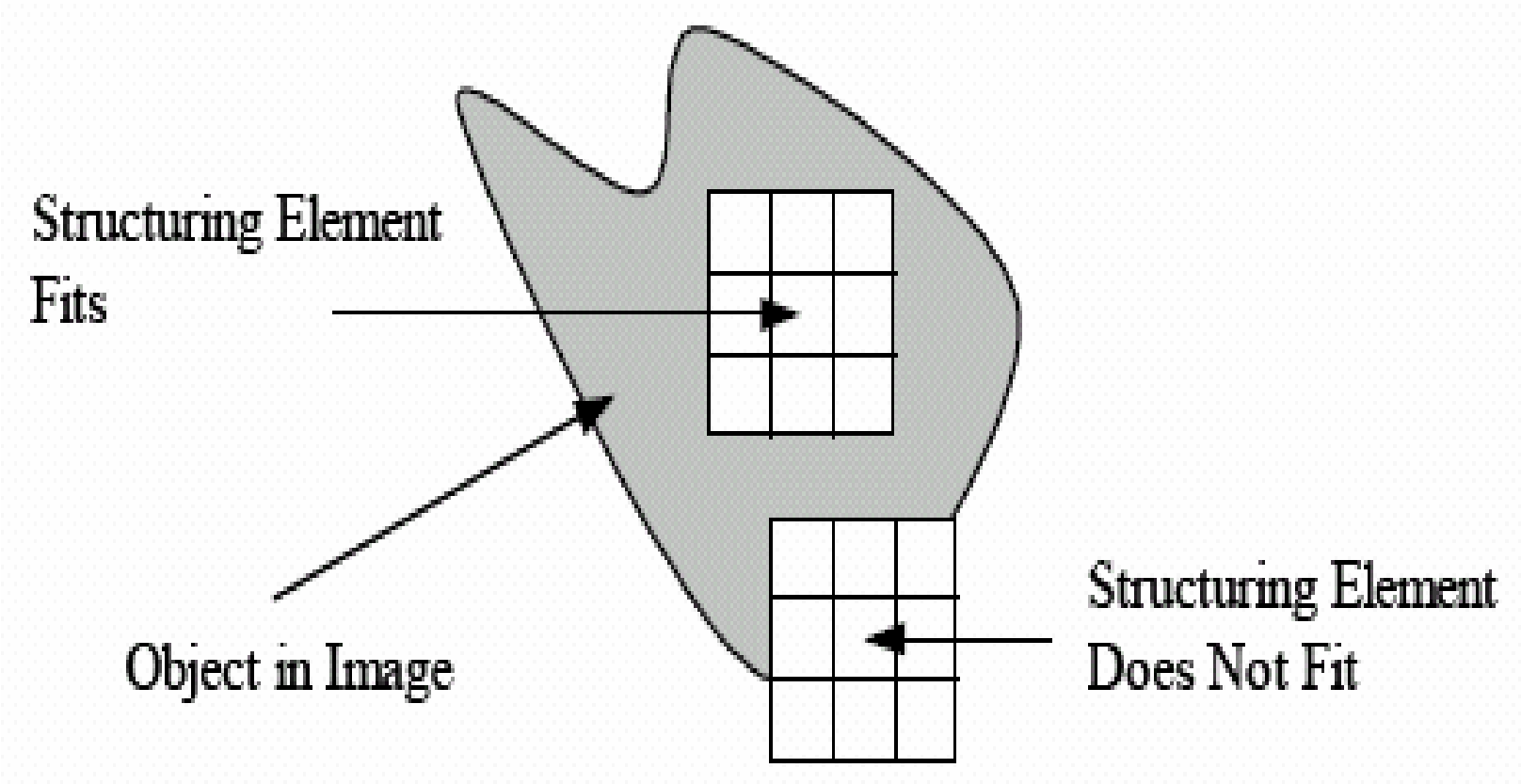

Input Image
20
40
60
80
100
120
20 40 60 80 100 120

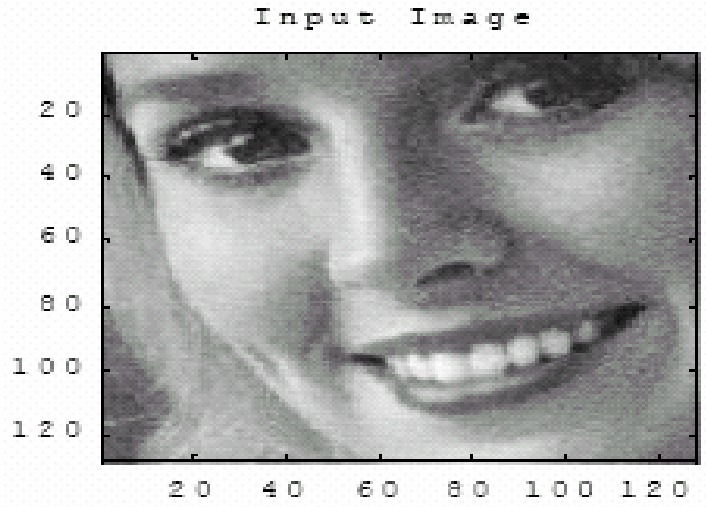

Filtered Image, Order = 2
20
40
60
80
100
120
20 40 60 80 100 120

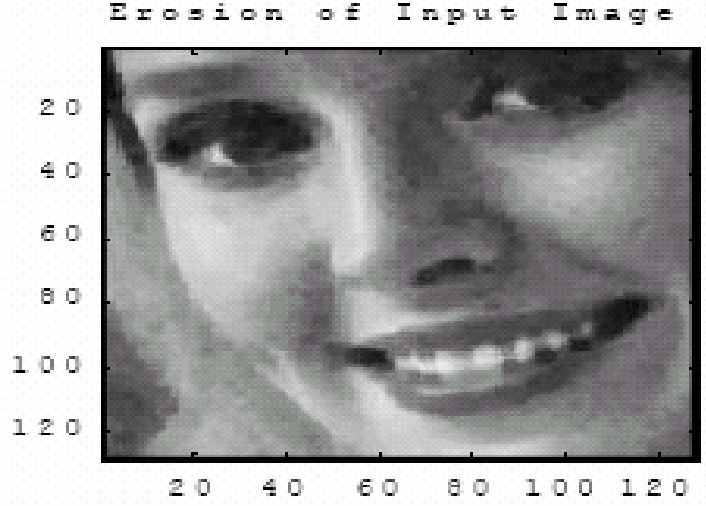

Filtered Image, Order = 5
20
40
60
80
100
120
20 40 60 80 100 120


Filtered Image, Order = 8
20
40
60
80
100
120
20 40 60 80 100 120

Morphological Operators




Input Image
20
40
60
80
100
120
20 40 60 80 100 120


Erosion of Input Image
20
40
60
80
100
120
20 40 60 80 100 120


Dilation of Input Image
20
40
60
80
100
120
20 40 60 80 100 120

Convolution

Input Window:

50	10	20
30	70	90
40	60	80

Convolution Mask:

1	1	1
1	2	1
1	1	1

Output Pixel:

_	_	_
_	58	_
_	_	_

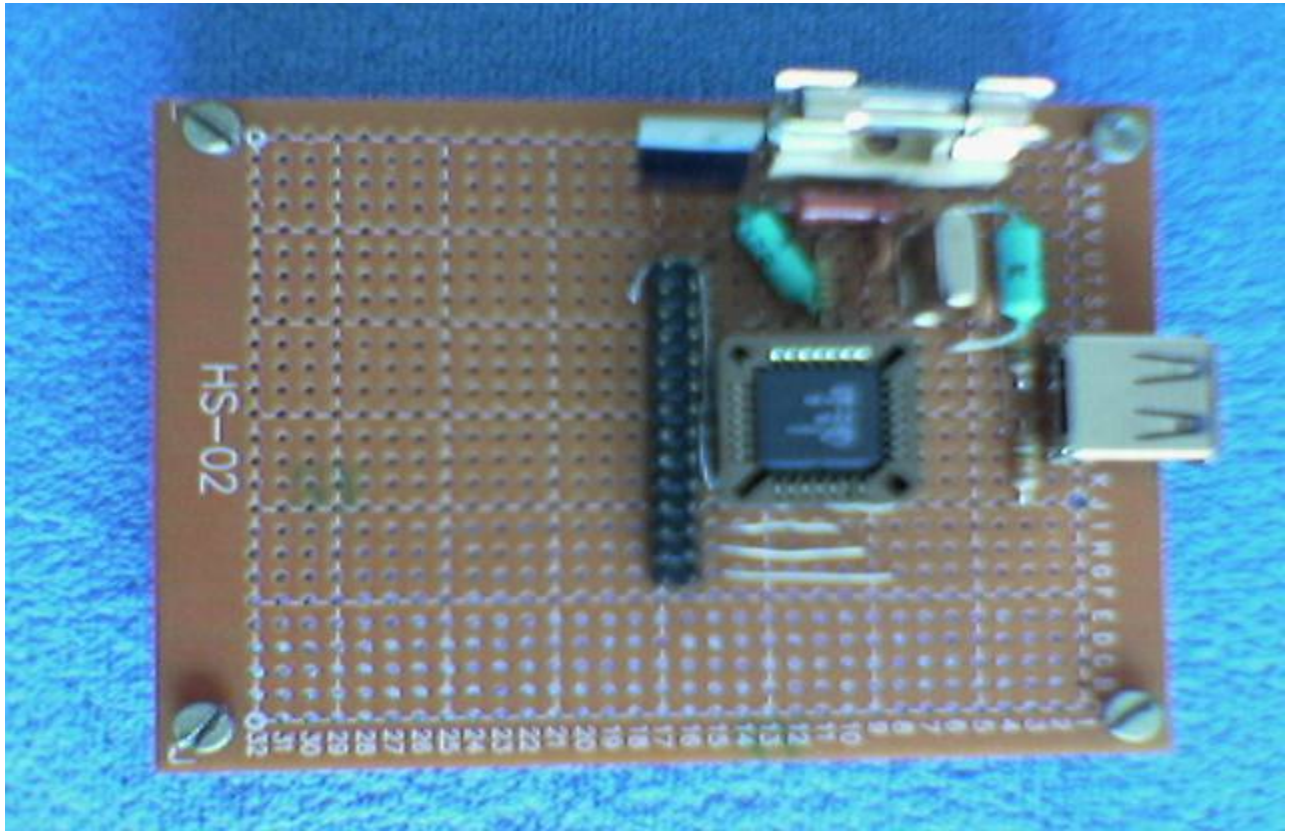
Convolution Output = (50*1 + 10*1 + 20*1 + 30*1 + 70*2 + 90*1 + 40*1 + 60*1 + 80*1)/9 = 57.7778 -> 58

IP/UDP over Ethernet

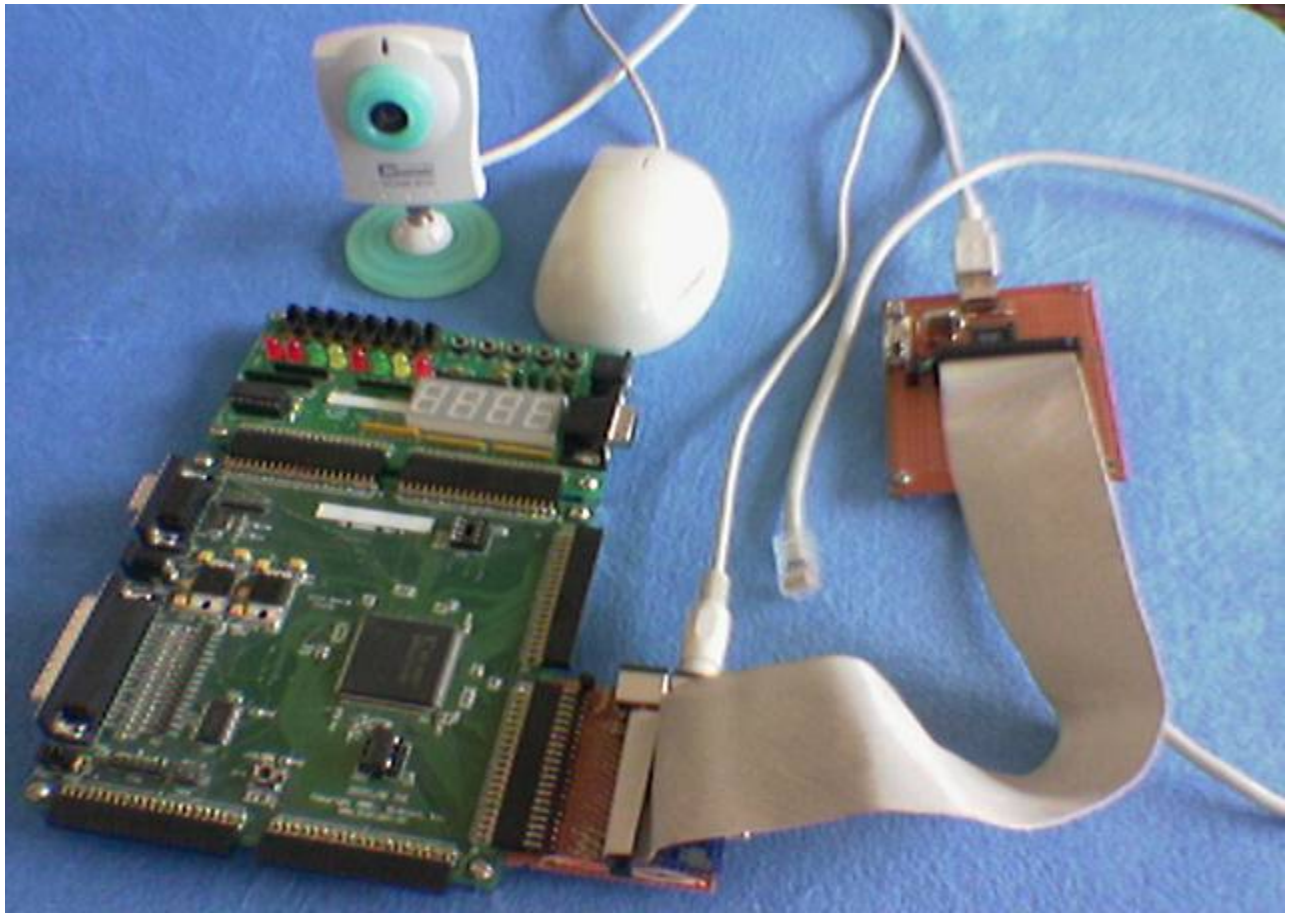
```
C:\>ipconfig /all

Windows IP Configuration

        Host Name . . . . . . . . . . . . : Duron
        Primary Dns Suffix  . . . . . . . :
        Node Type . . . . . . . . . . . . : Unknown
        IP Routing Enabled. . . . . . . . : No
        WINS Proxy Enabled. . . . . . . . : No

Ethernet adapter Local Area Connection:

        Connection-specific DNS Suffix  . :
        Description . . . . . . . . . . . : PCI Fast Ethernet Adapter

        Physical Address. . . . . . . . . : 00-07-95-0B-FB-AF
        Dhcp Enabled. . . . . . . . . . . : Yes
        Autoconfiguration Enabled . . . . : Yes
        IP Address. . . . . . . . . . . . : 192.168.0.2
        Subnet Mask . . . . . . . . . . . : 255.255.255.0
```

```
Waiting for packets (Press Ctrl-C to exit)...
Received 18 bytes from 192.168.0.44
00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F 10 11
Received 18 bytes from 192.168.0.44
00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F 10 11
Received 18 bytes from 192.168.0.44
00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F 10 11
Received 18 bytes from 192.168.0.44
00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F 10 11
```

USB Interface



Webcam Controller



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