



COMPUTER ENGINEERING

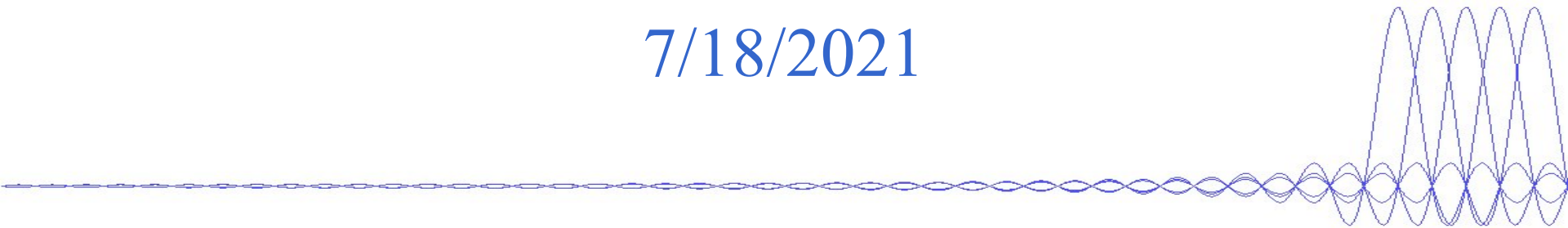


UIT
TRƯỜNG ĐẠI HỌC
CÔNG NGHỆ THÔNG TIN

DIGITAL SYSTEM DESIGN WITH HDL

FINAL PROJECT Median Filter Algorithm

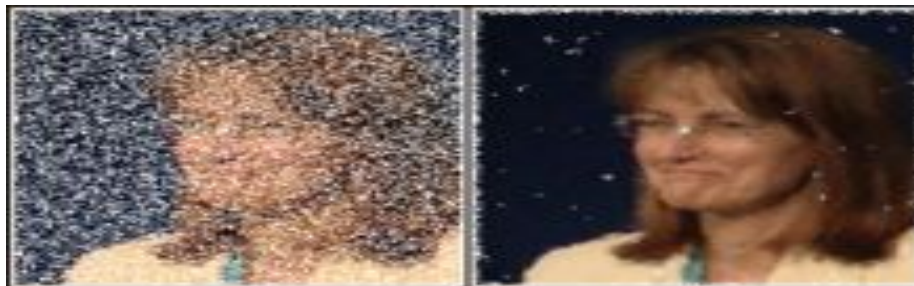
7/18/2021





Median Filter Overview

- The median filter is a non-linear digital filtering technique, often used to remove noise from an image or signal.
- Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise :



Use of a median filter to improve an image severely corrupted by defective pixels



Median Filter Overview

- Definition :
 - Given the sequence x_1, x_2, \dots, x_n monotonous with increasing (or decreasing) sequence. Then the median of the series of symbols $\text{Med}(\{x_n\})$ is defined:
 - + If n odd $\text{Med} = x[(n/2) + 1]$
 - + If n is even: $\text{Med} = x[n/2]$ or $\text{Med} = x[(n/2) + 1]$
- Usually filter with kernel 3×3 , 5×5 , 7×7 so n is usually probably.



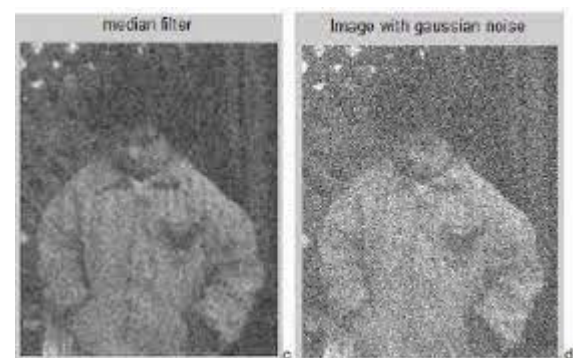
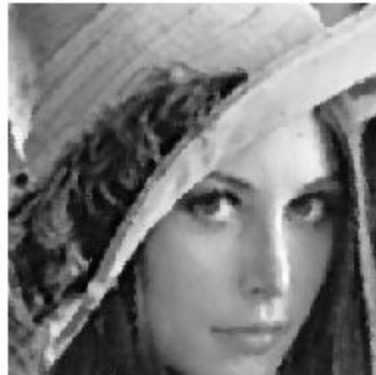
Median Filter Application

- Median filter is one of the well-known order-statistic filters due to its good performance for some specific noise types such as “Gaussian,” “random,” and “salt and pepper” noises.
- The median filter is the filtering technique used for noise removal from images and signals. Median filter is very crucial in the image processing field as it is well known for the preservation of edges during noise removal

Original



Filtered





Median Filtering

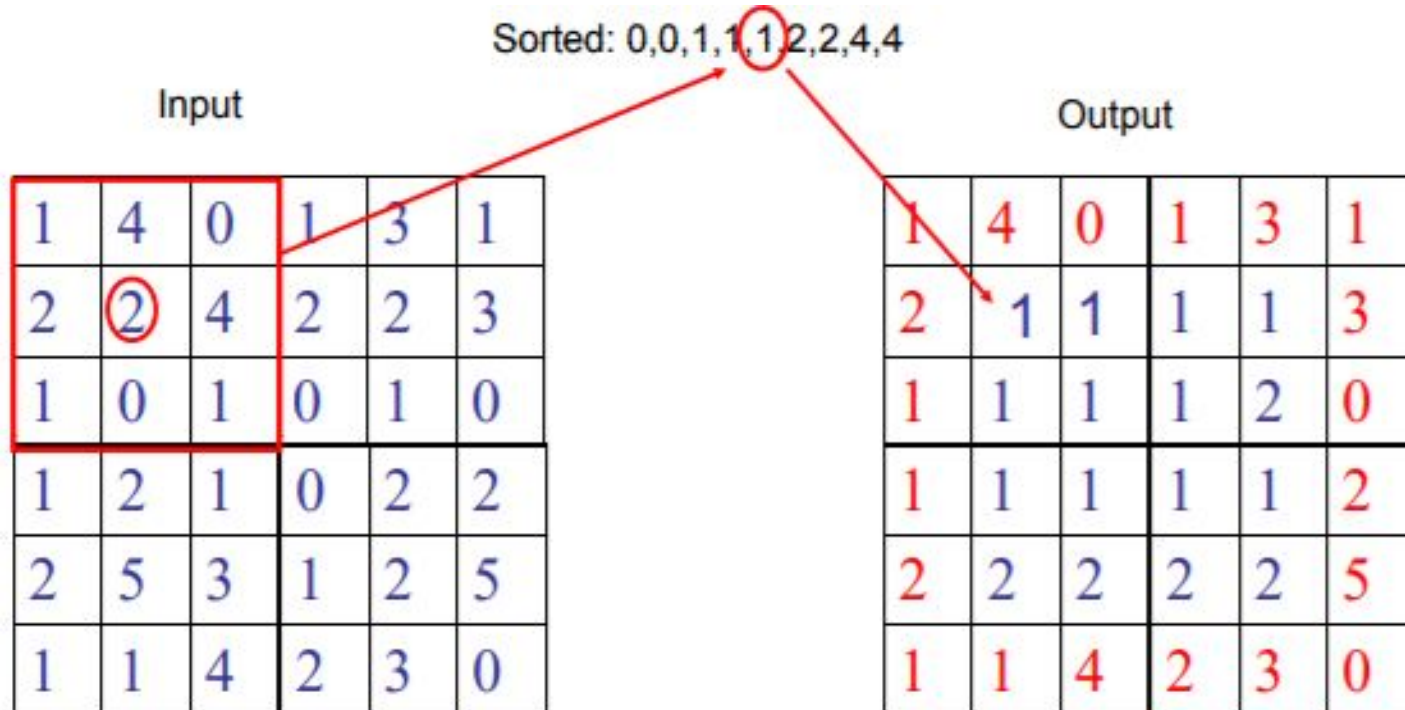


- The median filter works by moving through each image pixel, replacing each value with the average of the neighboring pixels. pattern of neighboring pixels is called "window", slide one by one over the entire image pixel, over the whole image.
- The meadian is calculated by first sorting all the pixel values from window to numerical order, and then replace the pixel under consideration with the center pixel value (median).



Median Filtering Example

- Example of 2D median filtering using a 3 x 3 window:
Keep contour values unchanged.





Median Filter Implementation



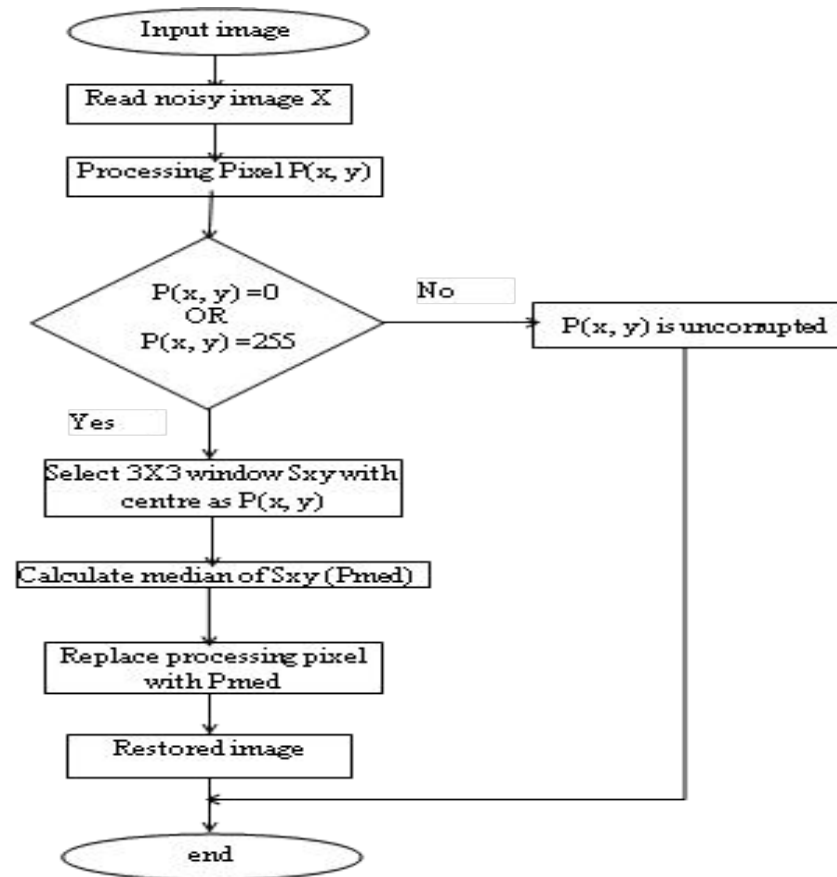
The steps of the algorithm:

- Select a S_{xy} two-way window of size 3×3 , with pixel processing $P(x, y)$.
- Calculate the median P_{med} of the S_{xy} window.
- The value of the processing pixel is replaced by P_{med} .
- Repeat the above step until the above steps are completed to get a complete image.



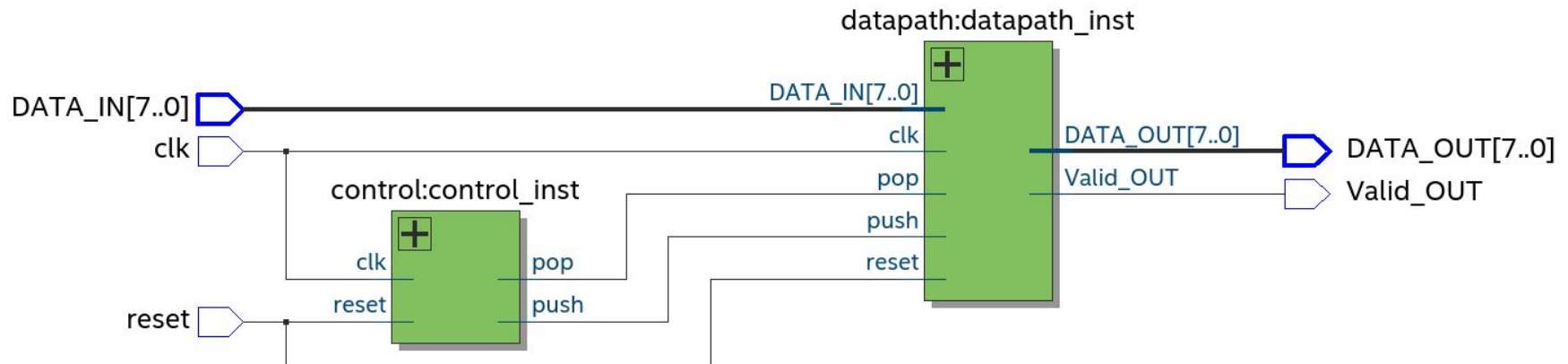
Median Filter Implementation

Flow Chart



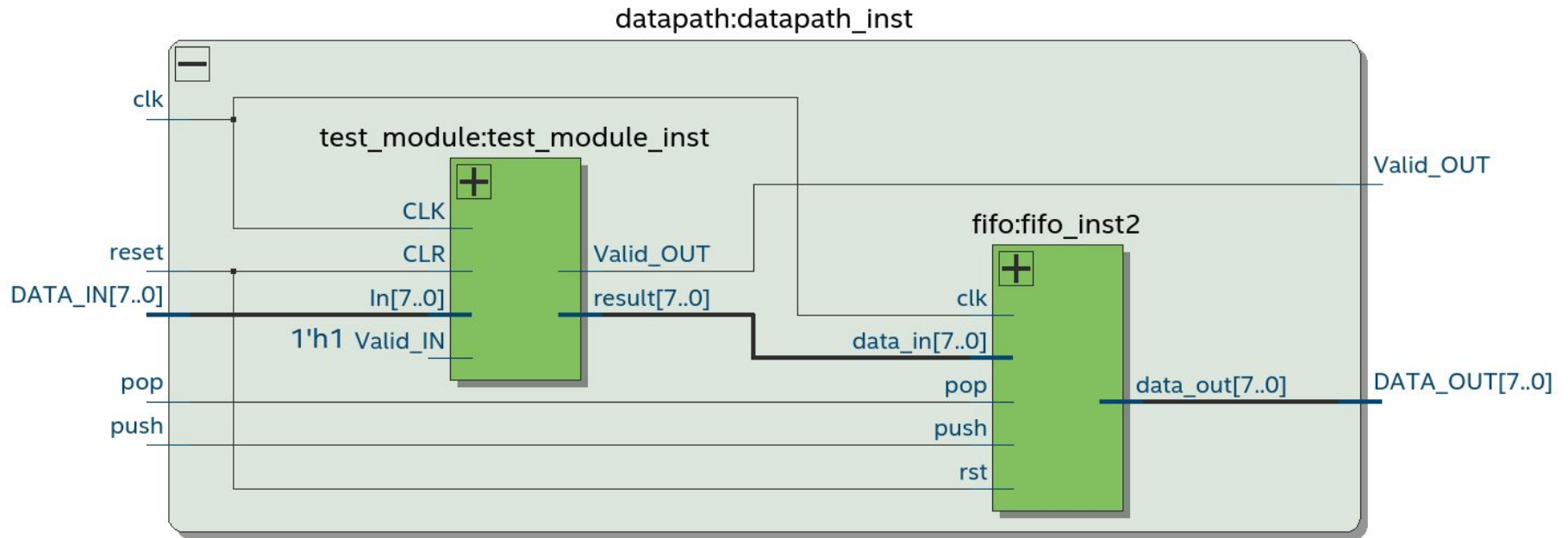


Median Filter Implementation



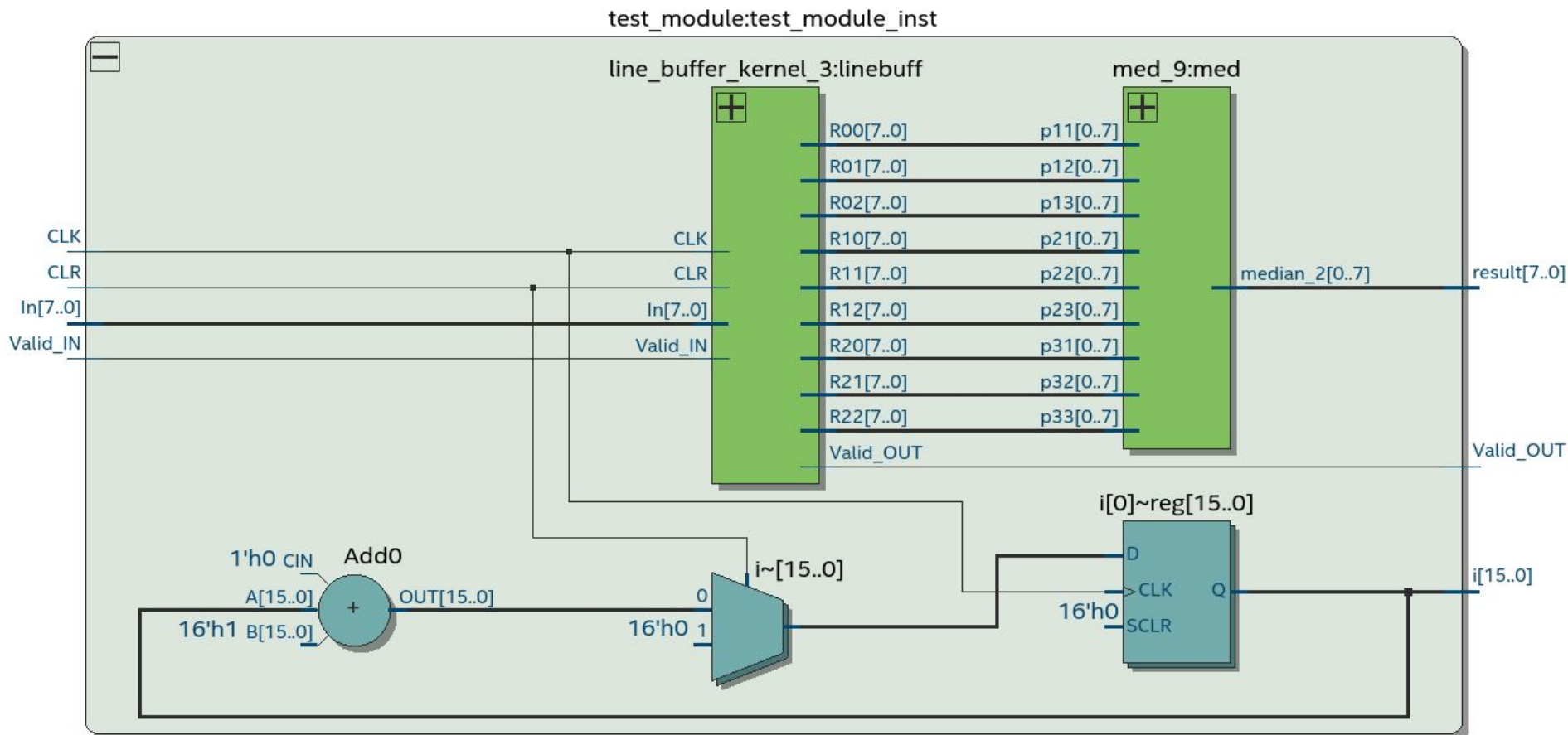


Datapath Module



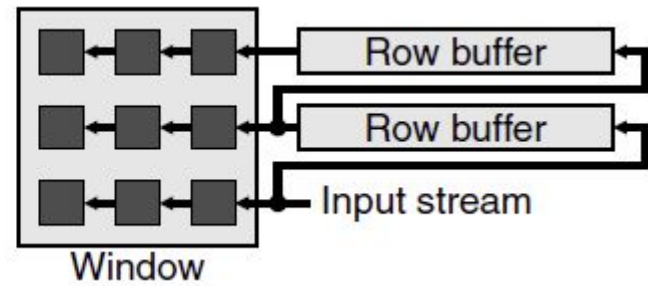
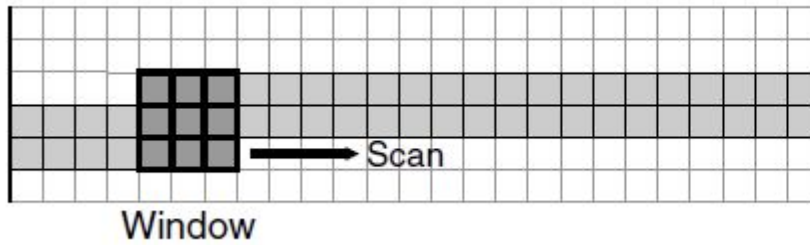


The function is used to calculate the Median value of the image





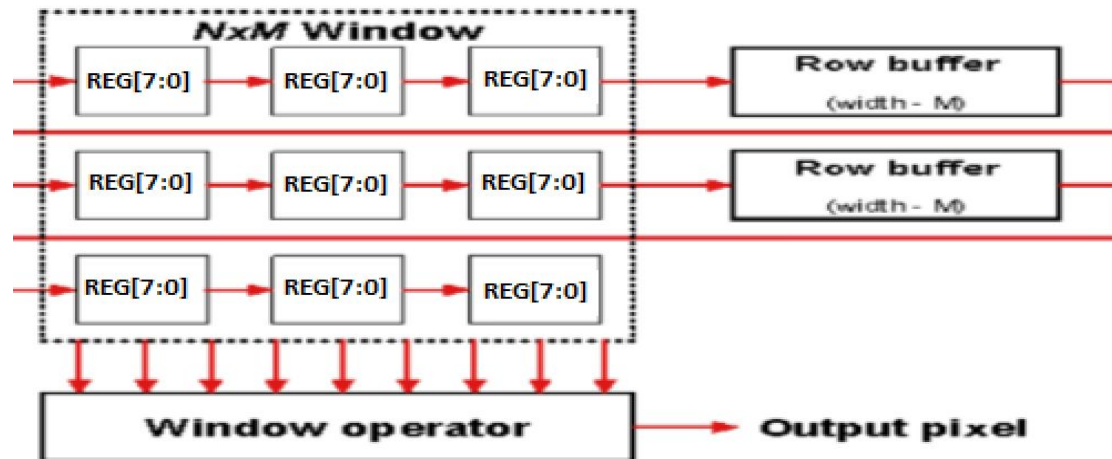
Test_module





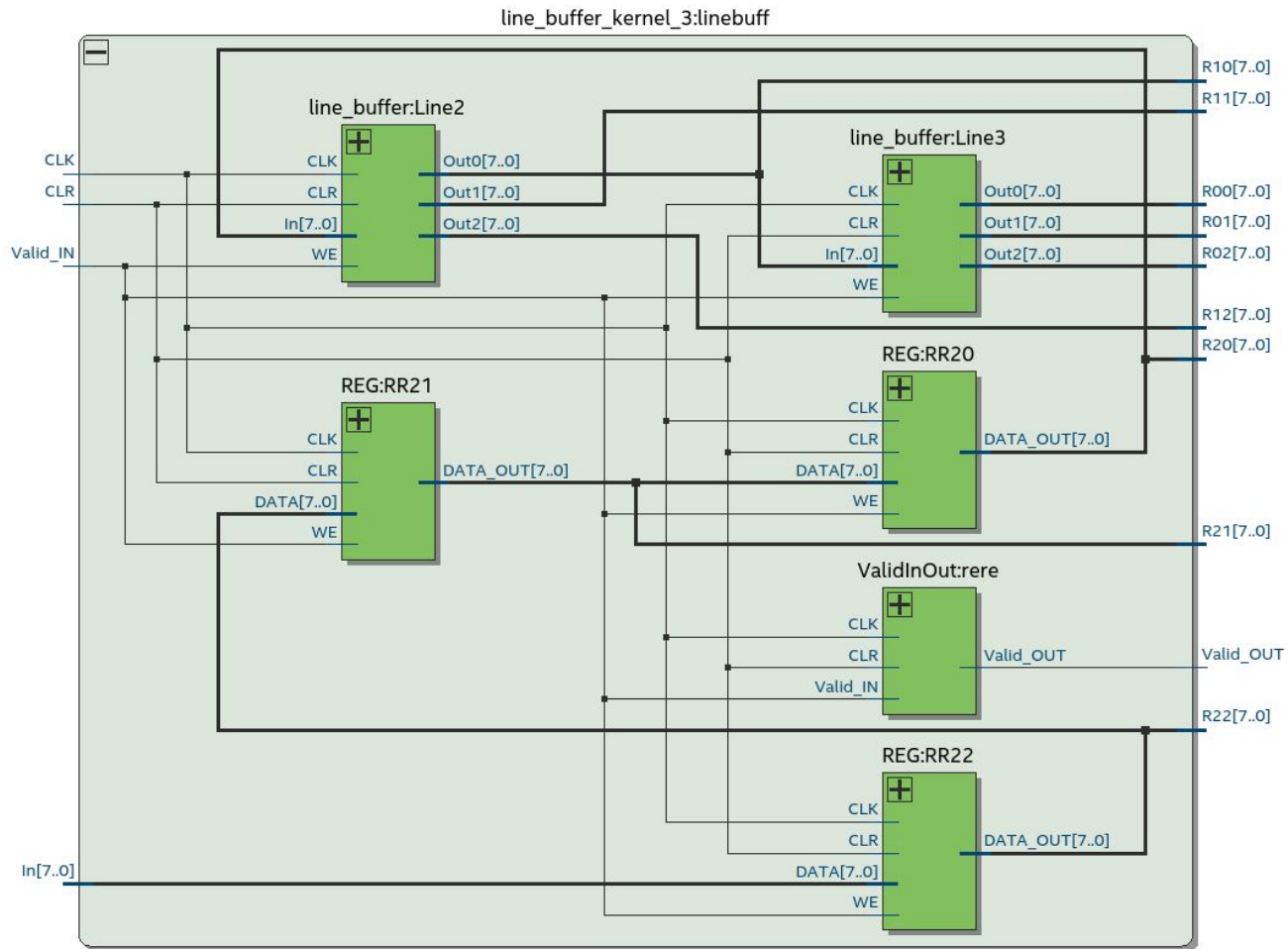
Line Buffer

- In digital image processing, line buffers are used very frequently. For example, when we need image matrix operations we need to buffer, such as image median filtering need line cache design





Line buffer Kernel

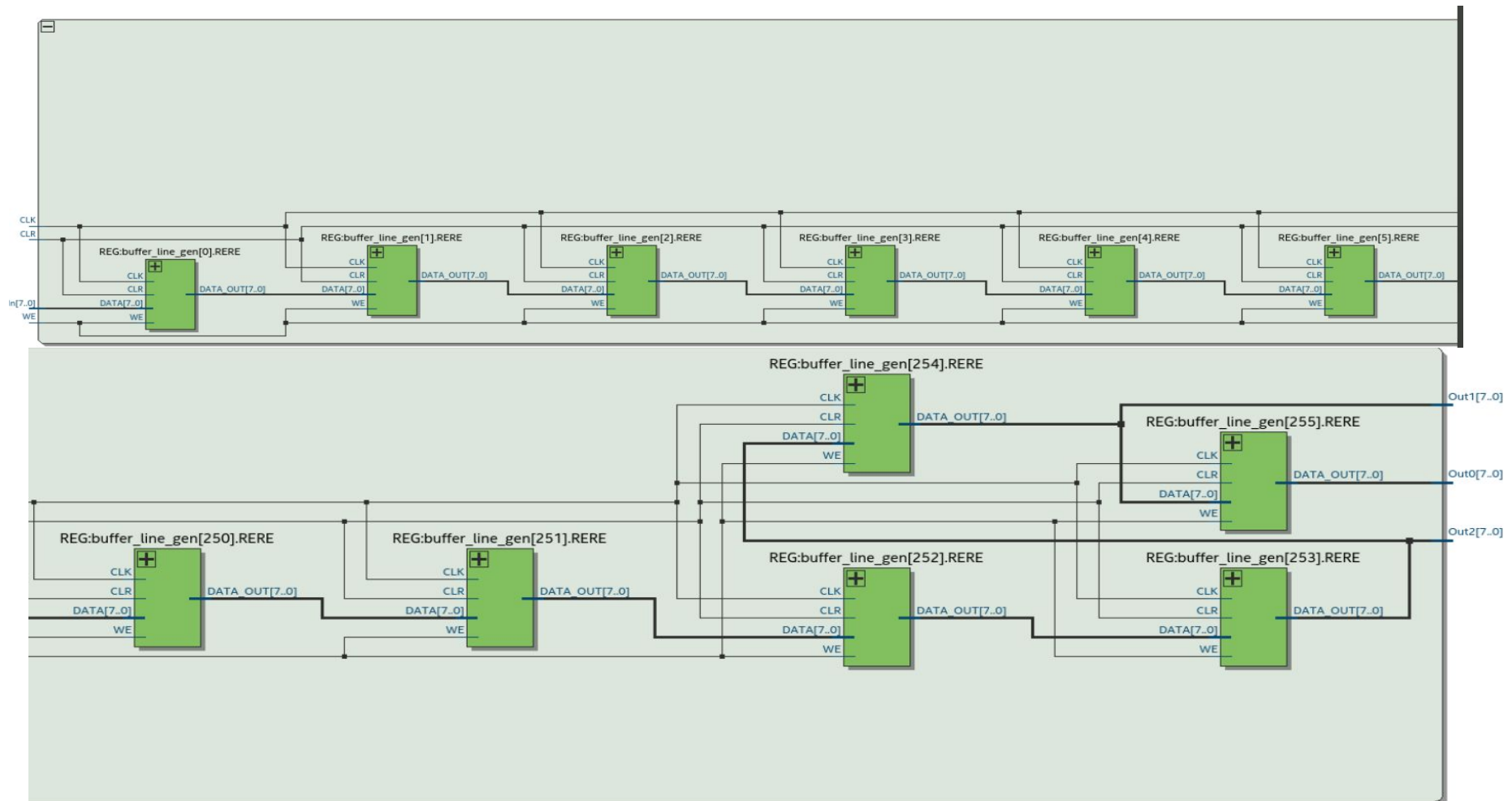




Line Buffer

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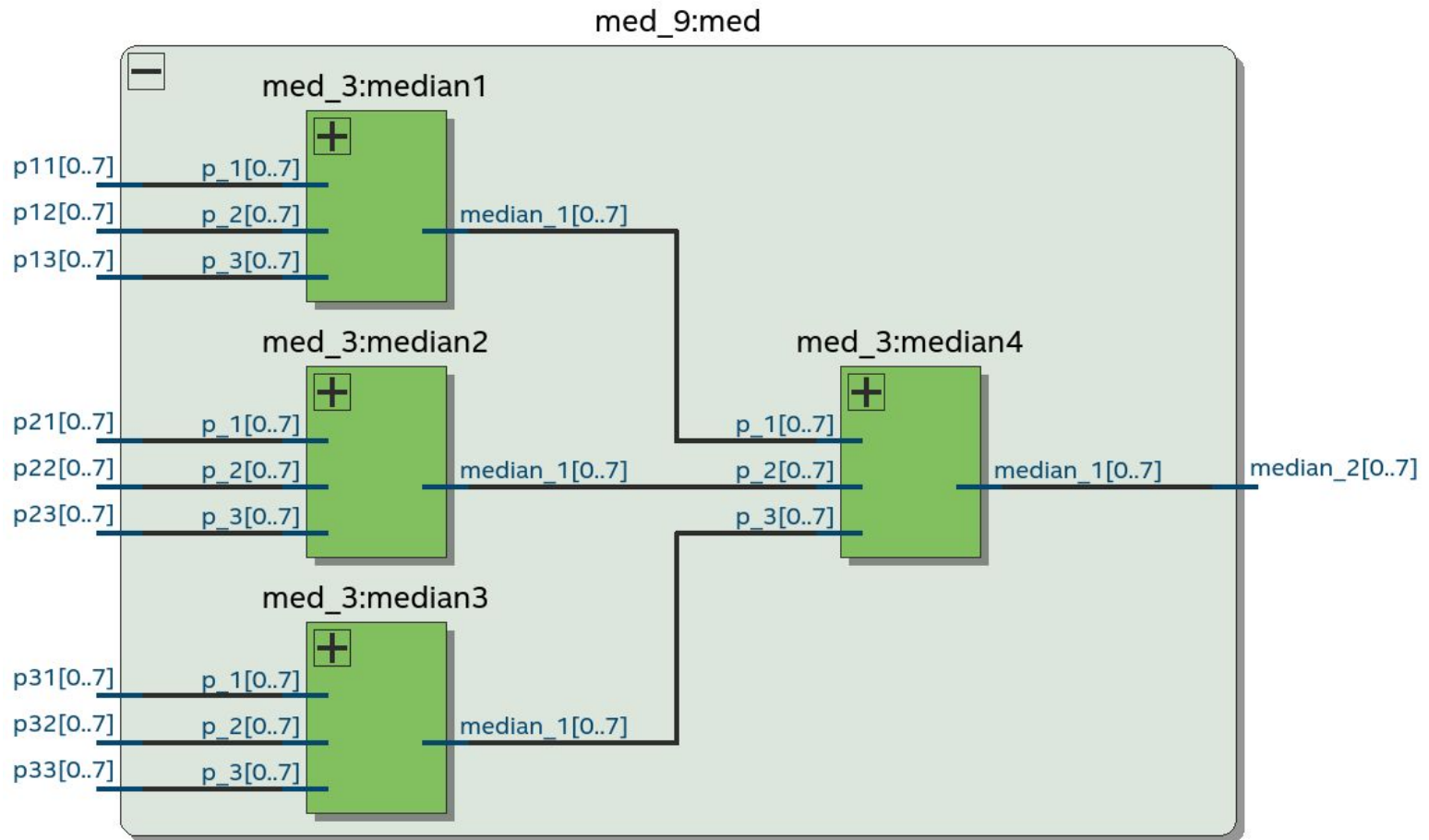
include 256 registers





Median 9 module

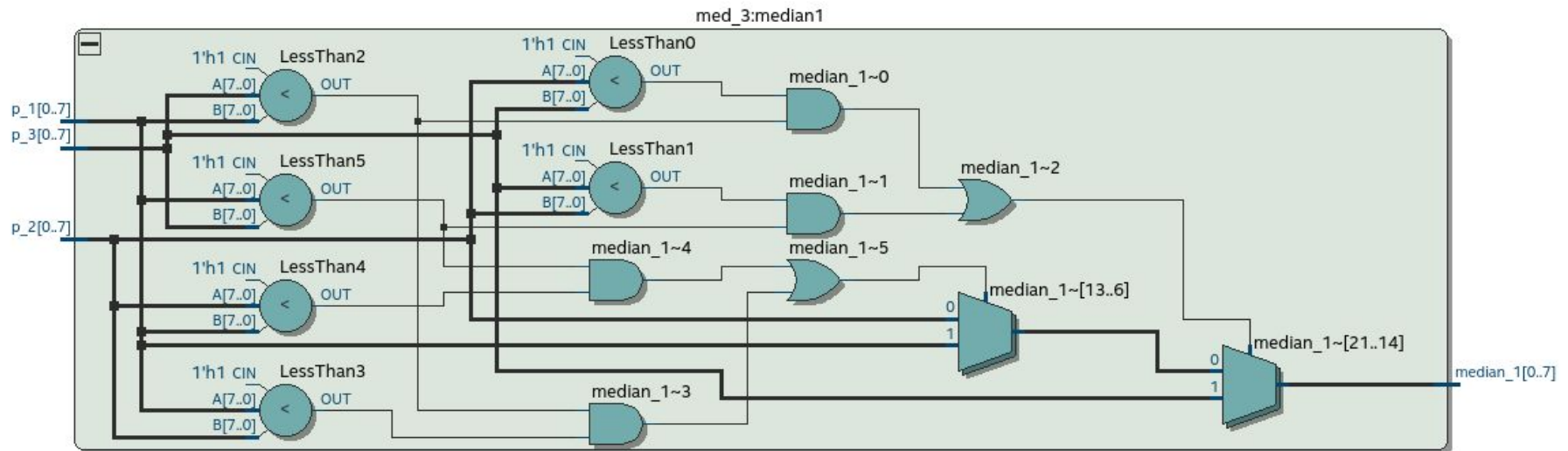
The output is median of three Med_3 module





Median 3 Module

The function of median 3 module is calculate median value of 3 adjacent values

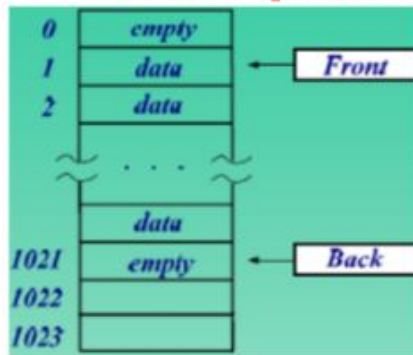




FIFO

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FIFO queue implemented with a 1K RAM



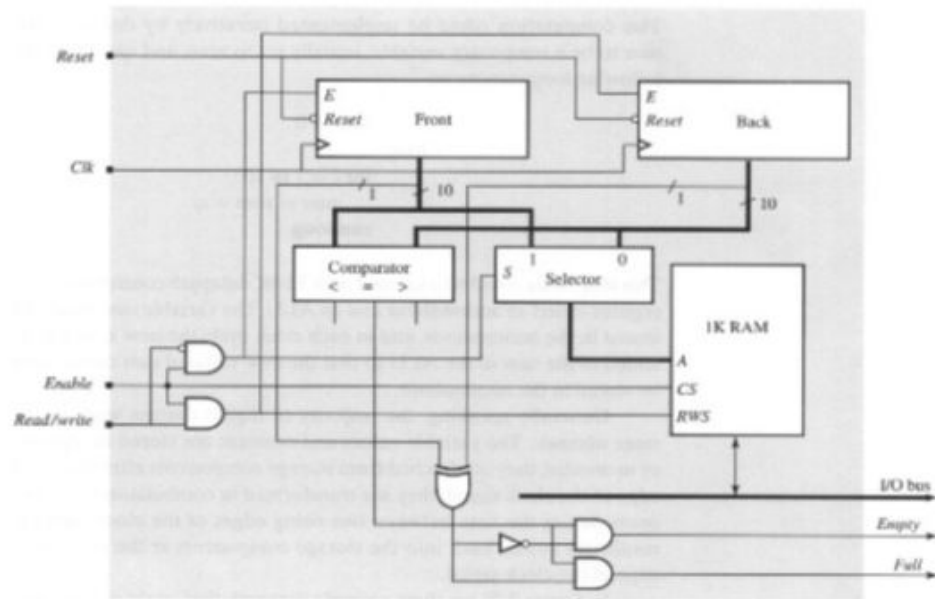
Symbolic design

Read/Write	Enable	Operations
X	0	No change
0	1	Read
1	1	Write

Operation table

Read/Write Enable		S	CS	RWS	E (Front)	E (Back)
X	0	X	0	X	0	0
0	1	1	1	0	1	0
1	1	0	1	1	0	1

Control table



Schematic



Design Results

Activities Image Viewer T7 Thg 7 17 21:10
ModelSim - INTEL FPGA STARTER EDITION 10.5b

File Edit View Compile Simulate Add Source Tools Layout Bookmarks Window Help

sim - Default
Instance
top_testbench top_testbe
top_inst top
#INITIAL#19 top_testbe
#ALWAYS#36 top_testbe
#ALWAYS#41 top_testbe
#vsim_capacity#

Ln#
16
17
18
19
20

```
integer pixel_data, pixel_result, i;  
  
initial begin  
    pixel_data = $fopen("test_gray.txt", "r");  
    pixel_result = $fopen("FPGA_Result.txt", "w");
```

result.png
100%
Properties
Size 256 x 256 pixels
Type PNG image
File Size 39,8 kB
Folder [src](#)
Aperture
Exposure
Focal Length
ISO
Metering
Camera
Date
Time

tmpBewolty...
100%
Properties
Size 256 x 256 pixels
Type PNG image
File Size 42,5 kB
Folder [tmp](#)
Aperture
Exposure
Focal Length
ISO
Metering
Camera
Date
Time

noisyimg256...
100%
Properties
Size 256 x 256 pixels
Type PNG image
File Size 152,5 kB
Folder [src](#)
Aperture
Exposure
Focal Length
ISO
Metering
Camera
Date
Time

Memory List sim
Wave
h datapath.v h top.v h test_module.v h top_testbench.v

Transcript
VSIM 28> run -all
** Warning: (vsim-3116) Problem reading symbols from linux-gate.so.1 : can not open ELF file.
** Warning: (vsim-3116) Problem reading symbols from /lib/i386-linux-gnu/libpthread.so.0 : module was loaded at an absolute address.
** Warning: (vsim-3116) Problem reading symbols from /lib/i386-linux-gnu/librt.so.1 : module was loaded at an absolute address.
** Warning: (vsim-3116) Problem reading symbols from /lib/i386-linux-gnu/libdl.so.2 : module was loaded at an absolute address.
** Warning: (vsim-3116) Problem reading symbols from /lib/i386-linux-gnu/libm.so.6 : module was loaded at an absolute address.
** Warning: (vsim-3116) Problem reading symbols from /lib/i386-linux-gnu/libc.so.6 : module was loaded at an absolute address.
** Warning: (vsim-3116) Problem reading symbols from /lib/ld-linux.so.2 : module was loaded at an absolute address.
** Warning: (vsim-3116) Problem reading symbols from /lib/i386-linux-gnu/libnss_files.so.2 : module was loaded at an absolute address.
** Note: \$finish : /home/dant/DATA/Median_Fillter_Verilog/src/verilog/top_testbench.v(30)
Time: 5263640 ns Iteration: 0 Instance: /top_testbench
1
Break in Module top_testbench at /home/dant/DATA/Median_Fillter_Verilog/src/verilog/top_testbench.v line 30
VSIM 29>

Ln: 30 Col: 0 Project : median Now: 5,263,640 ns Delta: 0 sim:/top_testbench/#INITIAL#19



Thank for your attention



Q&A