problem

In this homework we will synthesize the kernel function of the Gaussian blur and annotate the timing back to the platform from previous homework.
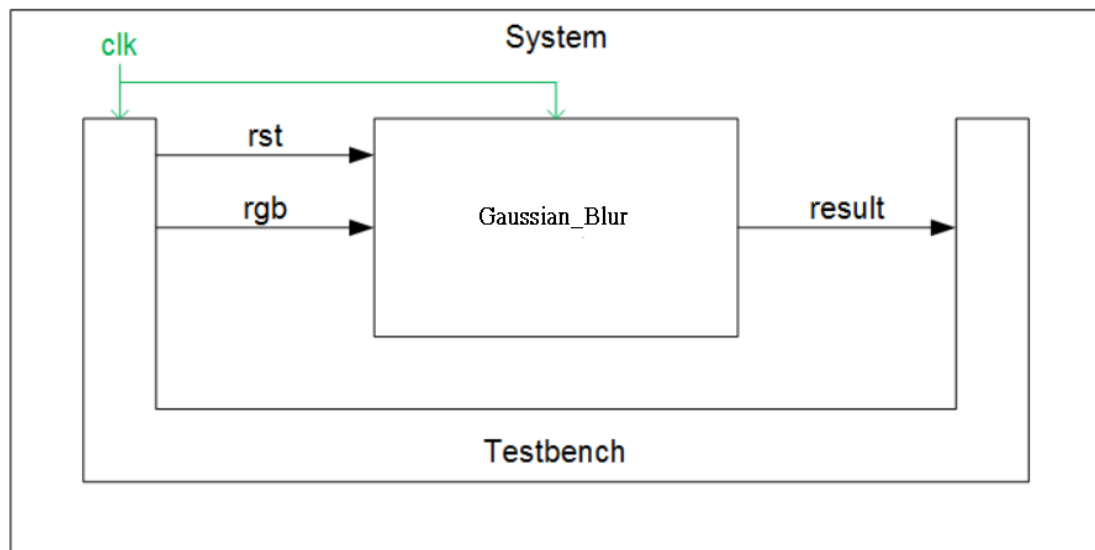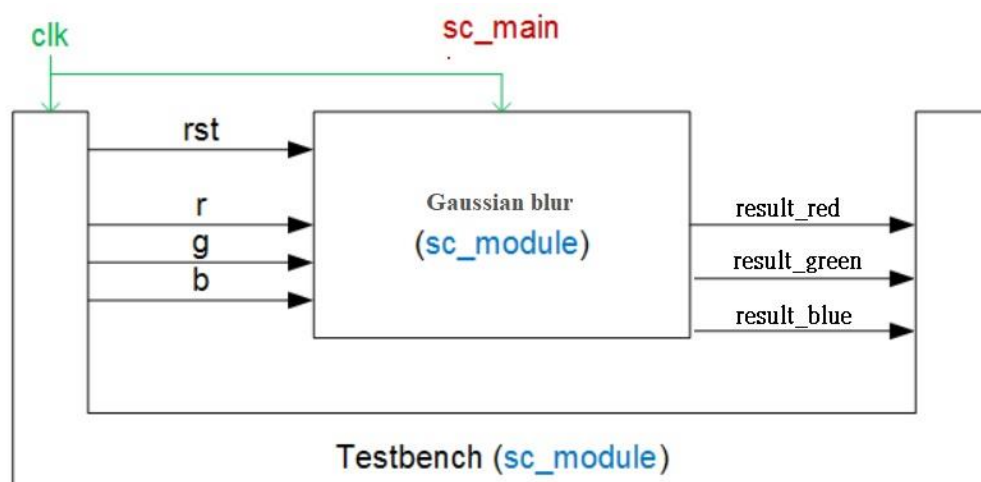
Solution algorithms

SystemC processes
A Gaussian blur with HLS
Architecture shown below:
non-splited:

splited:

Gaussian_Blur.cpp do filter with sc_module and Testbench.cpp do read/write file with sc_module and do data transfer by cynw_p2p, setting in system.cpp

data transfer channel

```
1   #include "System.h"
2   stem::System( sc_module_name n, str
3       tb("tb"), Gaussian_Blur("Gaussian
4   {
5       tb.i_clk(clk);
6       tb.o_rst(rst);
7       Gaussian_Blur.i_clk(clk);
8       Gaussian_Blur.i_rst(rst);
9       tb.o_rgb(rgb);
10      tb.i_result(result);
11      Gaussian_Blur.i_rgb(rgb);
12      Gaussian_Blur.o_result(result);
13
14   tb.read_bmp(input_bmp);
15  }
```

set channel with cynw_p2p and set signal with systemC datatype

```
17  public:
18    sc_in_clk i_clk;
19    sc_out<bool> o_rst;
20  #ifndef NATIVE_SYSTEMC
21    cynw_p2p< sc_dt::sc_uint<24> >::base_out o_rgb;
22    cynw_p2p< sc_dt::sc_uint<32> >::base_in i_result;
23  #else
```

set latency with reset, input, loop, output

```
34    #ifndef NATIVE_SYSTEMC
35        HLS_DEFINE_PROTOCOL("main_reset");
36        i_rgb.reset();
37        o_result.reset();
38    #endif
```

```
47    #ifndef NATIVE_SYSTEMC
48            {
49                HLS_DEFINE_PROTOCOL("input");
50                rgb = i_rgb.get();
51                wait();
52            }
53    #else
```

```
56          sc_uint<8> p_red = rgb.range(7,0);
57          sc_uint<8> p_green = rgb.range(15,8);
58          sc_uint<8> p_blue = rgb.range(23,16);
59          HLS_CONSTRAIN_LATENCY(0, 3, "lat01");
60          red += p_red * filter[u][v] / factor;
61          green += p_green * filter[u][v] / factor;
62          blue += p_blue * filter[u][v] / factor;
63        }
```

```
71    #ifndef NATIVE_SYSTEMC
72      {
73        HLS_DEFINE_PROTOCOL("output");
74        o_result.put(total);
75        wait();
76      }
77    #else
```

Experimental results

Before filter

After filter

non-splited

B

```
pixel : 589824

Info: /OSCI/SystemC: Simulation stopped by user.
Total run time = 13107190 ns
Simulated time == 13107250 ns
```

V_BASIC

Total run time = 13107190 ns

Area Metrics

Combinational Area:	1,296
Resource Comb. Area:	849
Mux Comb. Area:	382
Other Comb. Area:	65
Sequential Area:	590
Black Box Area:	-0
Total Bound Operations:	50
Total Area:	**1,886**

Resource Metrics

Number of Instances:	16
Widest Input or Output:	12
Number of Pipelined Instances:	0
Bound Operations:	18
Total Resource Area:	**849**

Mux Metrics

Number of Instances:	22
Widest Input or Output:	24
Largest Fanin:	3
Implicit Mux Area:	266
Explicit Mux Area:	116
Muxed Operations:	22
Total Mux Area:	**382**

Register Metrics

Register Count:	19
Register Bits:	82
Bound Register Operations:	31
Total Register Area:	**607**

Memory Metrics

Number of Instances:	1
Largest Memory (b):	0
Bound Memory Operations:	1
Total Memory Area:	**0**

Timing Metrics

Time Units:	ns
Clock Period:	10.00
Cycle Slack:	0.00
Path Delay Limit:	unset
Target Delay:	10.00
Worst Slack:	**7.49**

V_DPA

Total run time = 19005430 ns

Area Metrics

Combinational Area:	858
Resource Comb. Area:	384
Mux Comb. Area:	394
Other Comb. Area:	80
Sequential Area:	613
Black Box Area:	0
Total Bound Operations:	46
Total Area:	**1,471**

Resource Metrics

Number of Instances:	12
Widest Input or Output:	8
Number of Pipelined Instances:	0
Bound Operations:	14
Total Resource Area:	**384**

Mux Metrics

Number of Instances:	24
Widest Input or Output:	24
Largest Fanin:	3
Implicit Mux Area:	278
Explicit Mux Area:	116
Muxed Operations:	22
Total Mux Area:	**394**

Register Metrics

Register Count:	21
Register Bits:	85
Bound Register Operations:	31
Total Register Area:	**633**

Memory Metrics

Number of Instances:	1
Largest Memory (b):	0
Bound Memory Operations:	1
Total Memory Area:	**0**

Timing Metrics

Time Units:	ns
Clock Period:	10.00
Cycle Slack:	0.00
Path Delay Limit:	unset
Target Delay:	10.00
Worst Slack:	**8.30**

splited

B

```
pixel : 589824

Info: /OSCI/SystemC: Simulation stopped by user.
Total run time = 26214390 ns
Simulated time == 26214450 ns
```

V_BASIC

Total run time = 26214390 ns

Area Metrics

Combinational Area:	1,015
Resource Comb. Area:	500
Mux Comb. Area:	401
Other Comb. Area:	114
Sequential Area:	540
Black Box Area:	0
Total Bound Operations:	84
Total Area:	**1,555**

Timing Metrics

Time Units:	ns
Clock Period:	10.00
Cycle Slack:	0.00
Path Delay Limit:	unset
Target Delay:	10.00
Worst Slack:	**7.44**

Resource Metrics

Number of Instances:	22
Widest Input or Output:	12
Number of Pipelined Instances:	0
Bound Operations:	26
Total Resource Area:	**500**

Mux Metrics

Number of Instances:	26
Widest Input or Output:	12
Largest Fanin:	7
Implicit Mux Area:	224
Explicit Mux Area:	177
Muxed Operations:	43
Total Mux Area:	**401**

Register Metrics

Register Count:	29
Register Bits:	78
Bound Register Operations:	57
Total Register Area:	**575**

Memory Metrics

Number of Instances:	1
Largest Memory (b):	0
Bound Memory Operations:	1
Total Memory Area:	**0**

V_DPA

Total run time = 38010870 ns

Area Metrics

Combinational Area:	802
Resource Comb. Area:	458
Mux Comb. Area:	247
Other Comb. Area:	97
Sequential Area:	568
Black Box Area:	-0
Total Bound Operations:	74
Total Area:	**1,370**

Timing Metrics

Time Units:	ns
Clock Period:	10.00
Cycle Slack:	0.00
Path Delay Limit:	unset
Target Delay:	10.00
Worst Slack:	**8.11**

Resource Metrics

Number of Instances:	19
Widest Input or Output:	12
Number of Pipelined Instances:	0
Bound Operations:	21
Total Resource Area:	**458**

Mux Metrics

Number of Instances:	19
Widest Input or Output:	12
Largest Fanin:	7
Implicit Mux Area:	240
Explicit Mux Area:	7
Muxed Operations:	34
Total Mux Area:	**247**

Register Metrics

Register Count:	26
Register Bits:	78
Bound Register Operations:	52
Total Register Area:	**598**

Memory Metrics

Number of Instances:	1
Largest Memory (b):	0
Bound Memory Operations:	1
Total Memory Area:	**0**

Discussions and conclusions

From above report we can see that simulation non-splited is shorter than splited, and area splited is bigger than non-splited, so it must to choice what is more important to require and cost.

Before this homework I do lab06 to learn the architecture of HLS, and this homework I learn about HLS architecture and coding in C and systemC. I think HLS is very useful to synthesis. I derive much benefit in this class, thanks.