DEMOSAICING

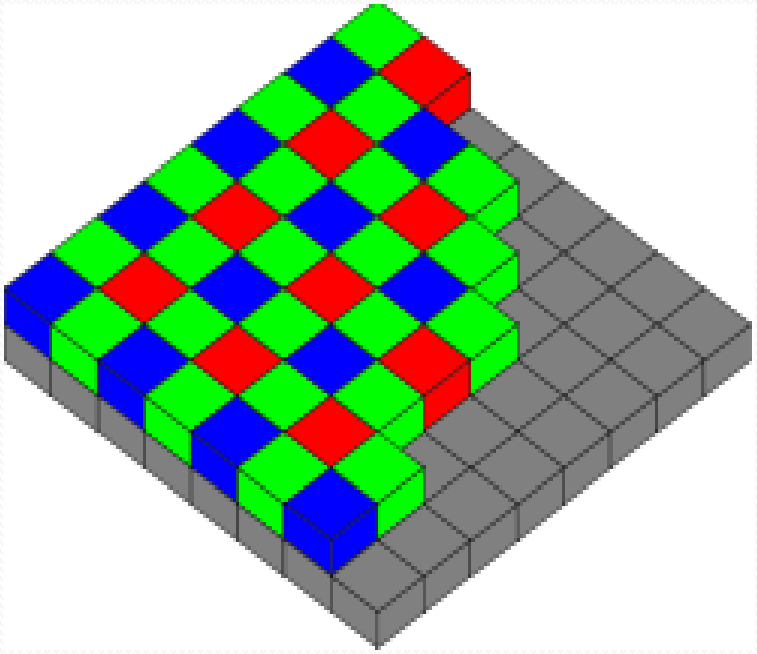
Project of ECE641

Jialiang Wu & Liang Xu

Demosaicing and CFA

- A **demosaicing** algorithm is a digital image process used to reconstruct a full color image from the incomplete color samples output from an image sensor overlaid with a color filter array (CFA). Also known as CFA interpolation or color reconstruction
- A color filter array is a mosaic of color filters in front of the image sensor

Bayer filter



G	R	G	R	G	R	
B	G	B	G	B	G	
G	R	G	R	G	R	
B	G	B	G	B	G	
G	R	G	R	G	R	
B	G	B	G	B	G	

Figure 1. The Bayer arrangement of color filters on the pixel array of an image sensor.

Demosaicing Algorithm

- nearest-neighbor interpolation
- bilinear interpolation
- bicubic interpolation
- spline interpolation
- Lanczos resampling.

Bilinear Interpolation

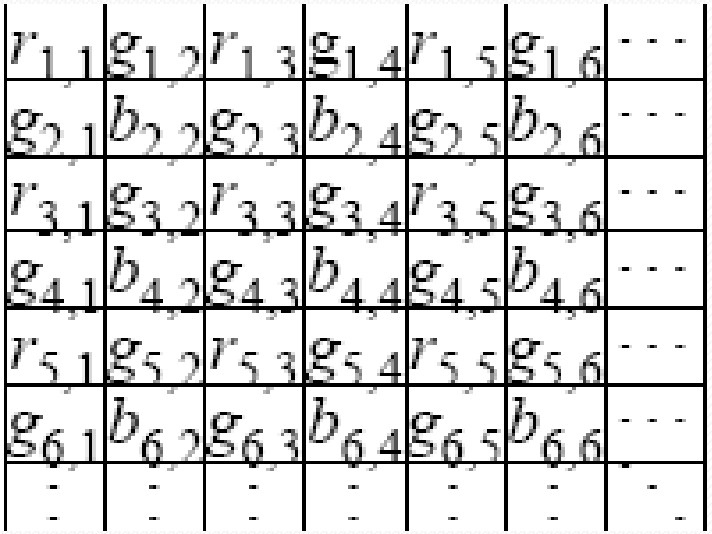


Figure 2. The Bayer CFA pattern, pixels numbered for reference

bilinear interpolation, whereby the red value of a non-red pixel is computed as the average adjacent red pixels, and similarly for blue and green.

For example:
$R(3,3)=r3,3$,
$G(3,3)=(g2,3+g3,2+g3,4+g4,3)/4$,
$B(3,3)=(b2,2+b2,4+b4,2+b4,4)/4$,
$G(3,4)=g3,4$, $B(3,4)=(b2,4+b4,4)/2$,
$R(3,4)=(r3,3+r3,5)/2$,
$B(4,4)=b4,4$.

Project Goal

- In this project, we will use the bilinear demosaicking algorithms to get color image from bayer pattern image by using FPGA.



Figure 3. The image information saved in single CCD.



Figure 4. original color image

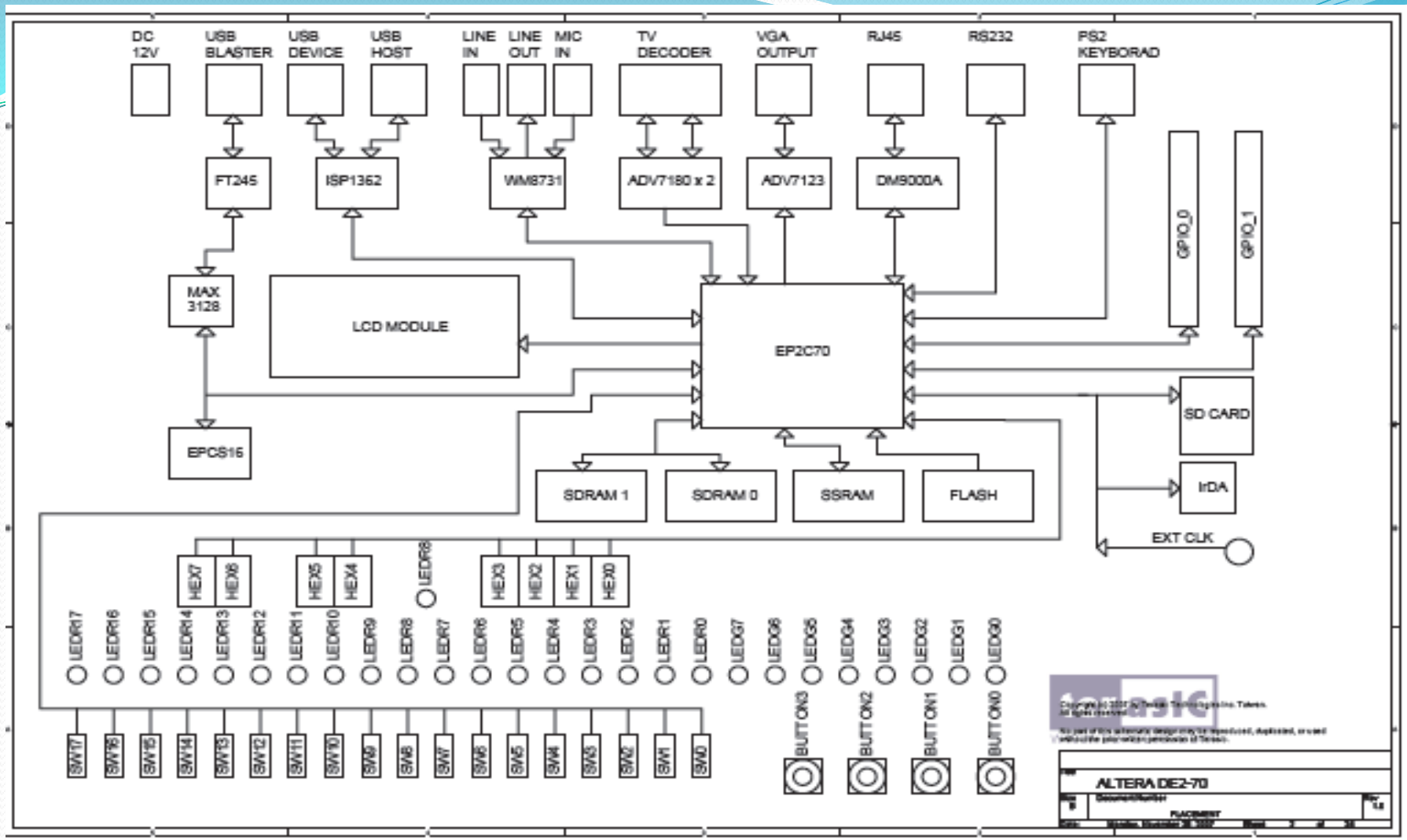


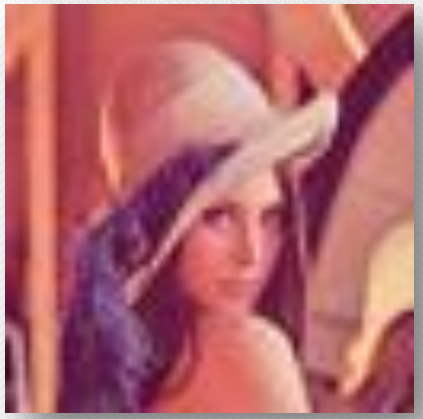
Figure 5. DE2_70_schematics

Usage

Total logic elements	2,930 / 68,416 (4 %)
Total combinational functions	2,926 / 68,416 (4 %)
Dedicated logic registers	1,585 / 68,416 (2 %)
Total registers	1585
Total pins	52 / 622 (8 %)

Worst-case tsu	8.904 ns
Worst-case tco	18.726 ns
Worst-case th	3.240 ns
Clock Setup: 'clk'	23.64 MHz (period = 42.302 ns)

Bayer Pattern





r	g	r	g	…
g	b	g	b	…
r	g	r	g	…
g	b	g	b	…
…	…	…	…	…

Two queues

r	g	r	g	…
g	b	g	b	…
r	g	r	g	…
g	b	g	b	…
…	…	…	…	…

queue	color_type value	color_type value	color_type value	color_type value	color_type value

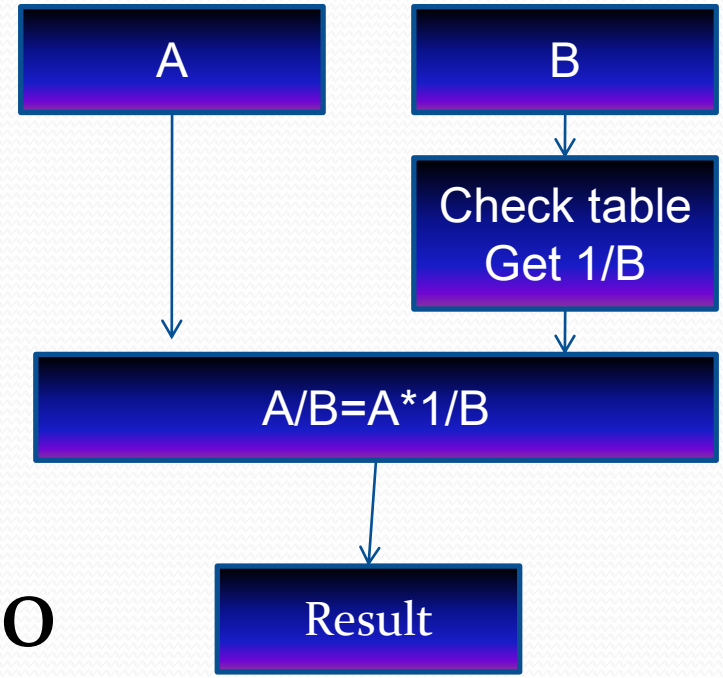
pre_que : l + 1

que : l + 2

Procedure

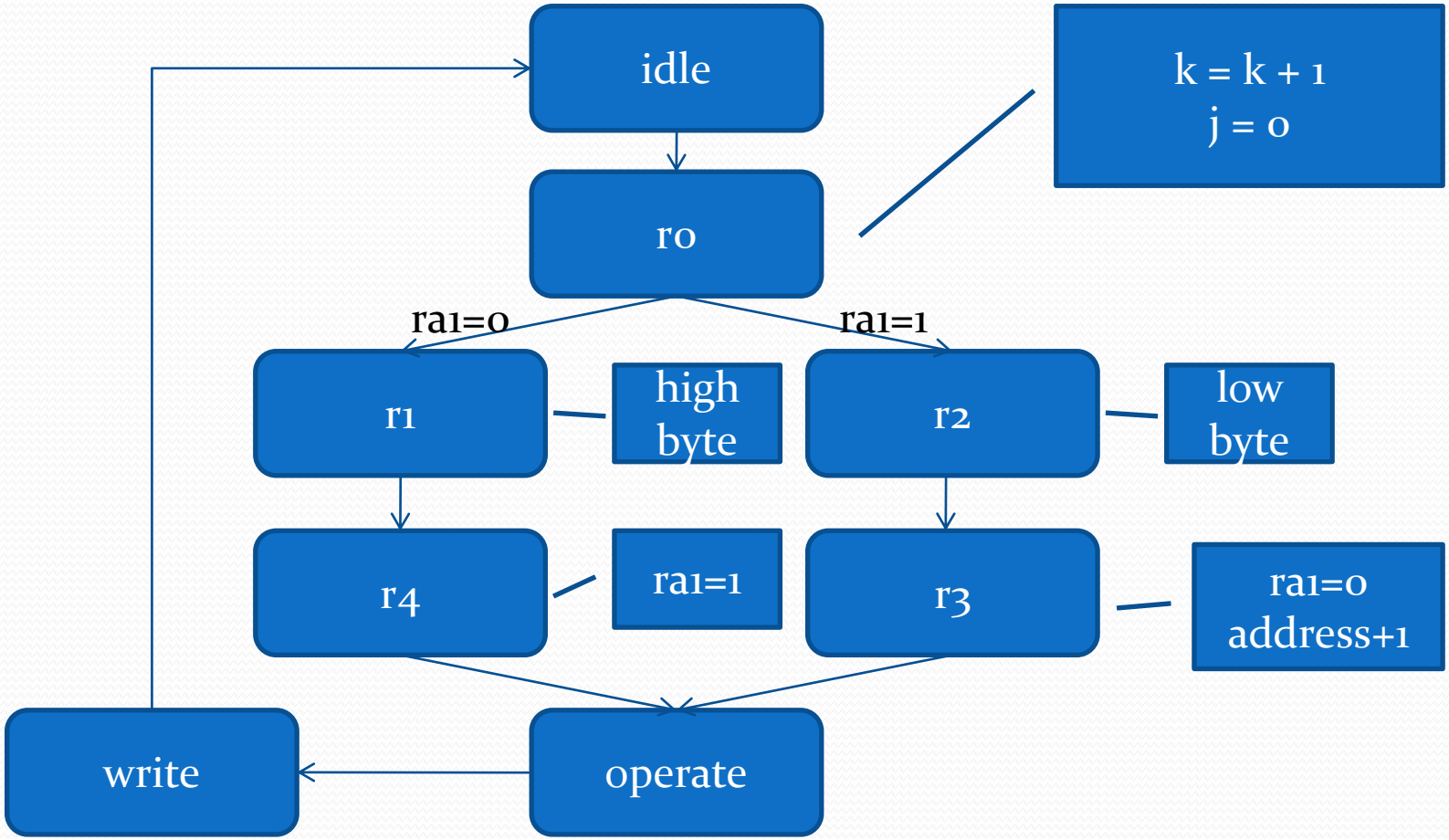
(a+b)/2 (a+b+c)/3 (a+b+c+d)/4

divide

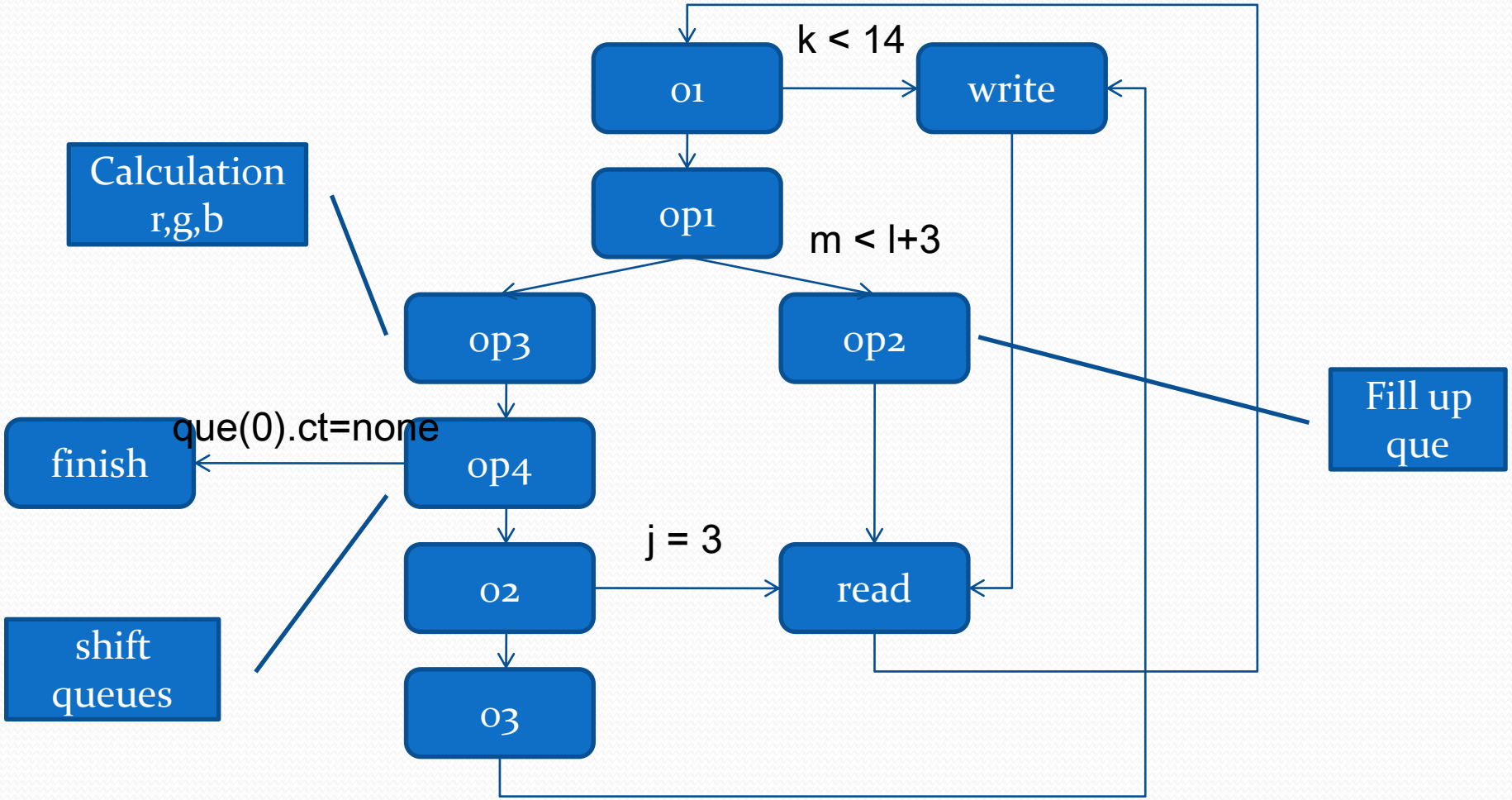


1/3 : 00101010

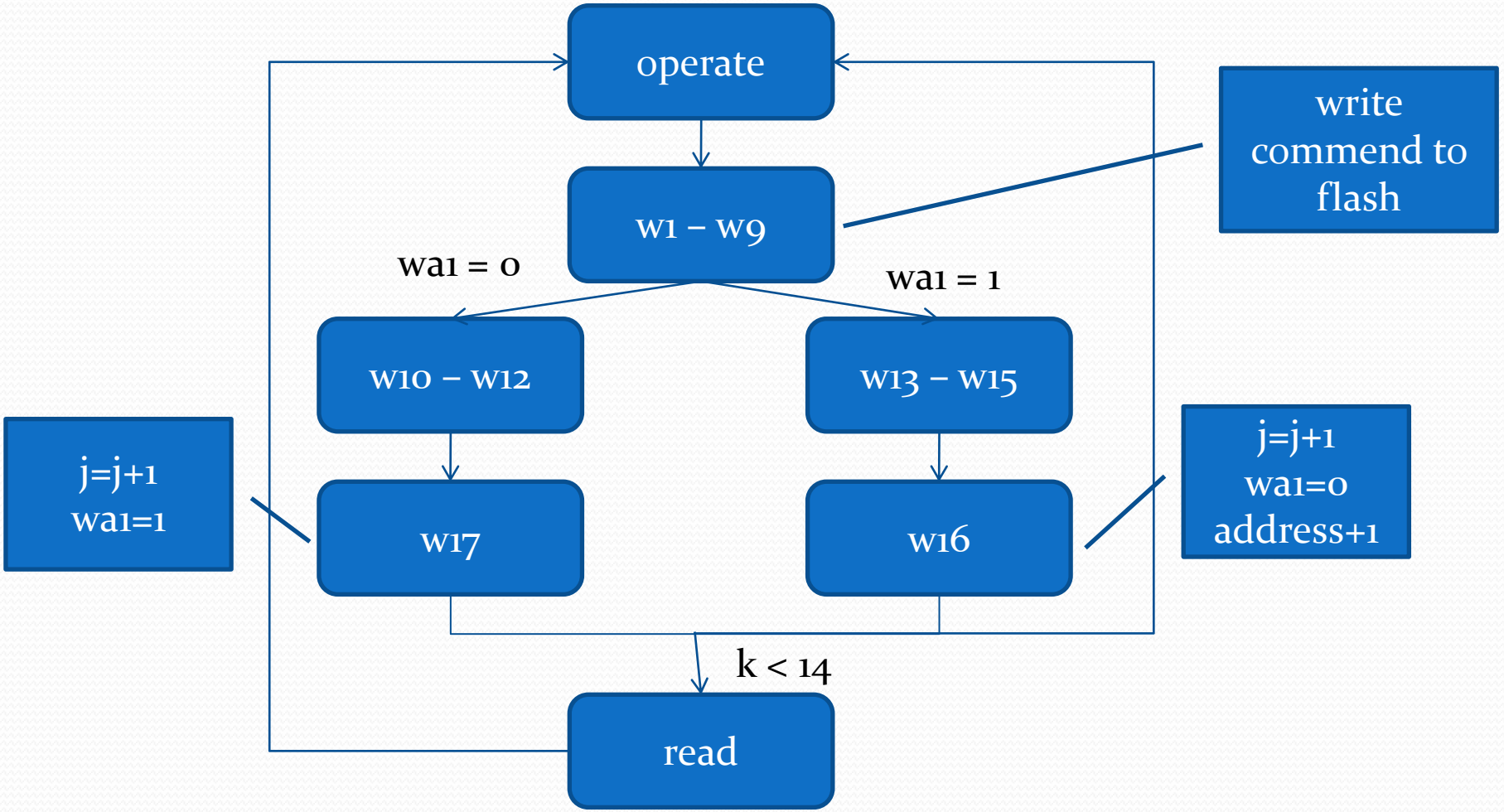
Flow Diagram-Read



Flow Diagram-Operate

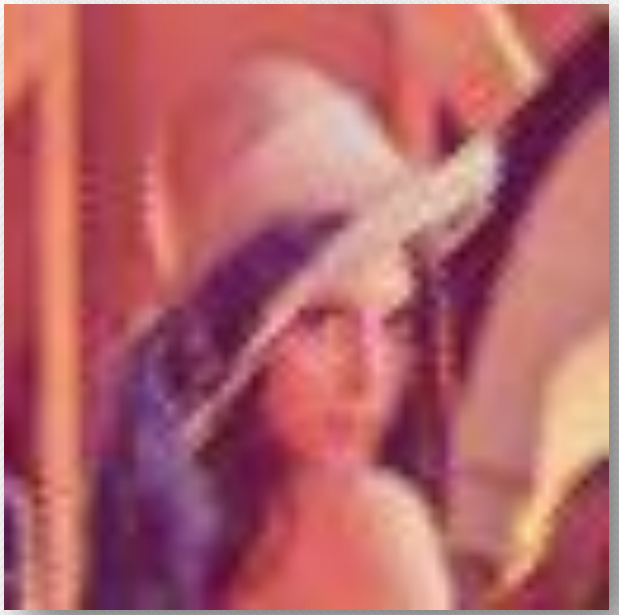


Flow Diagram-Write



Result Analysis





- PSNR = 25.48dB

- **Reference:**

- [1] Ron Kimmel, “Demosaicing: Image Eeconstruction from Color CCD Samples,” IEEE transactions on image processing, vol. 8, NO. 9, September 1999.
- [2] Jim Adams, Ken Parulski and Kevin Spaulding, “Color Processing in Digital Cameras,” Eastman Kodak Company.
- [3] Yangjing Long, “Image Based Source Camera Identification using
- Demosaicking,” Department of Mathematics School of Science Shanghai Jiaotong University, Shanghai, 200240, China.

Thank you!