

# Summer Internship – Image Processing with SDSoC (Software Defined System on Chip).

## Introduction and Background

This project was completed during the summer of 2016 in the department of Electronic and Electrical Engineering. The project objective was to focus on a new software application called “SDSoC” released by Xilinx. SDSoC is a revolutionary program designed for software engineers to program Zynq FPGA (Field Programmable Gated Array) boards using only C/C++ where previously it would have required a hardware engineer with good knowledge of the board design to mimic the same program.

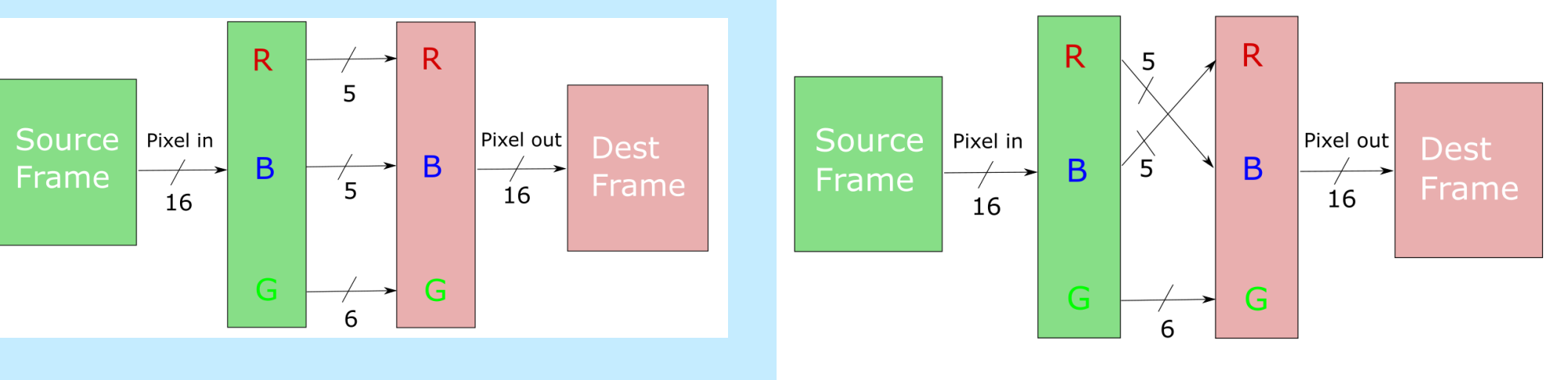
My goal for the project was to use this program in an image processing application in order to understand how the program operates and to gain a good understanding of basic image processing by writing the functions from scratch.

## Colour Manipulation Processing

In order to understand how to program image processing filters from scratch, I first needed to be able to manipulate each pixel individually. With this concept, two filters were written: Pass-through (colour swap) and Grayscale conversion.

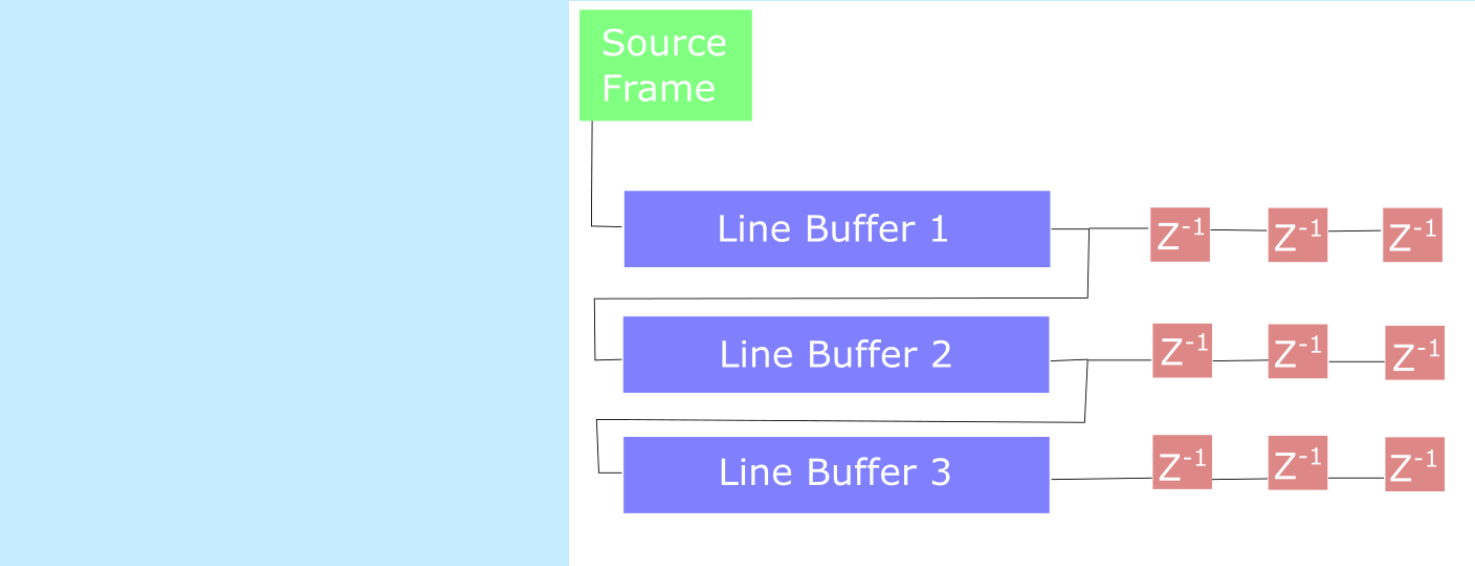
### Pass-through (Colour Swap) Filter

The pass-through filter operates by separating the colours of each pixel, swapping one of the colours and then combining the colours together again.



### Average Filter

The average filter is a much more complicated filter where multiple pixels are being processed at once. This function takes the average of all pixels in the window and assigns that value to the target pixel.

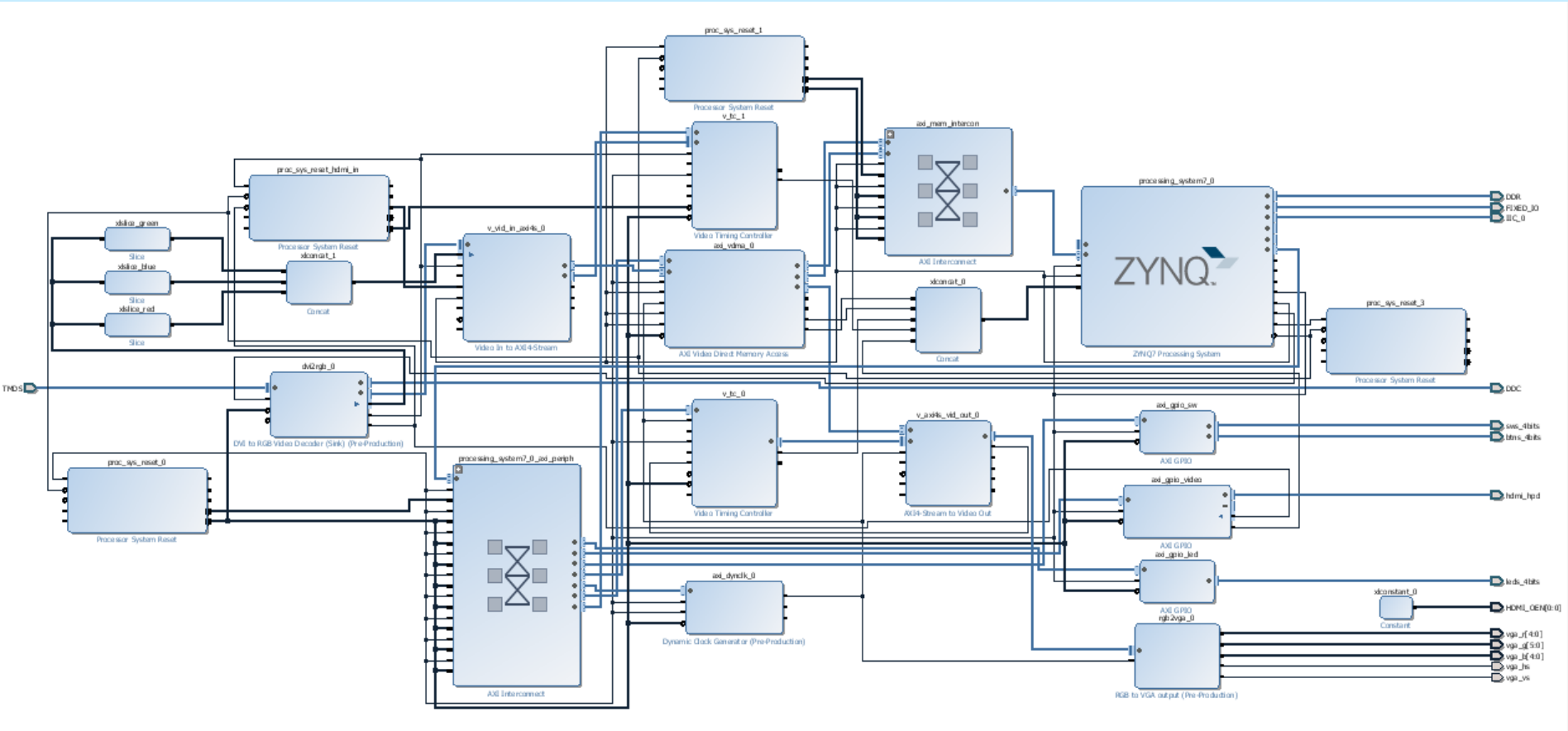


$$Z_{avg} = \frac{Z_1 + Z_2 + Z_3 + Z_4 + Z_5 + Z_6 + Z_7 + Z_8 + Z_9}{9}$$



## Hardware Platform

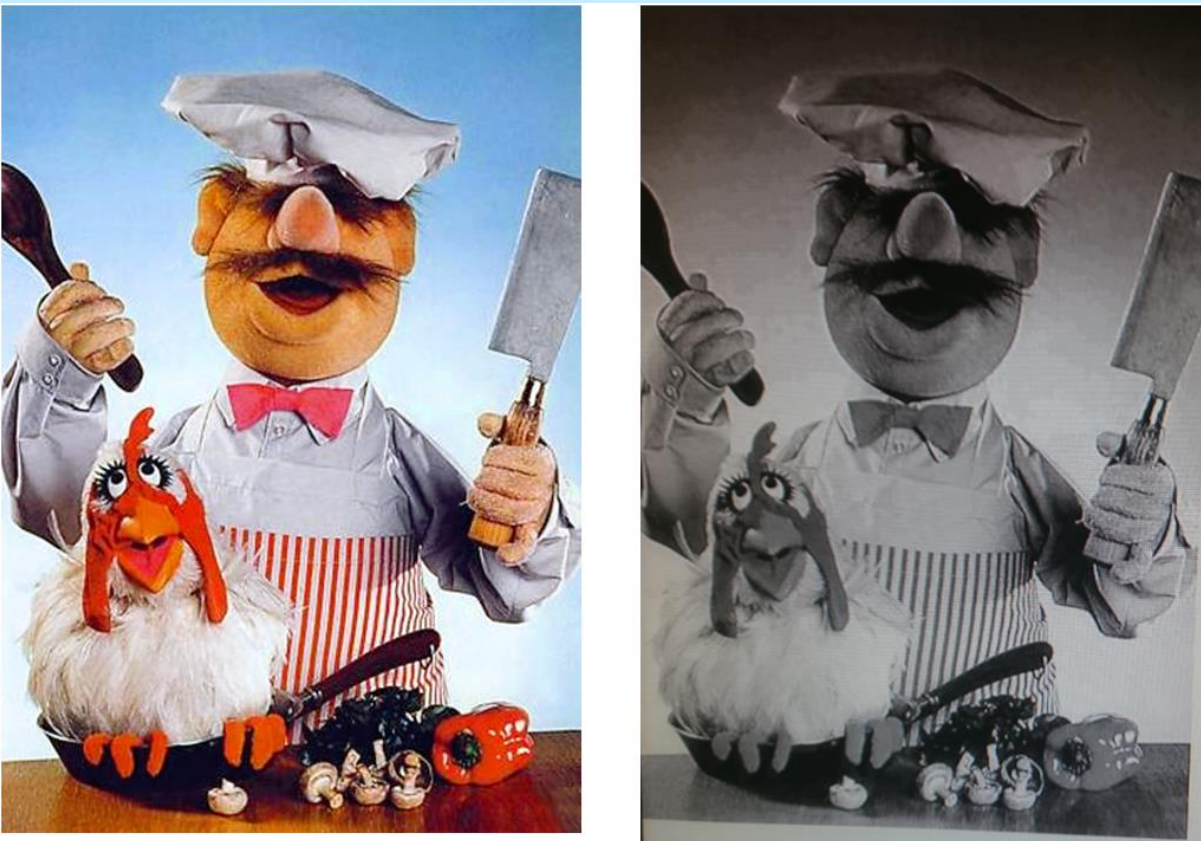
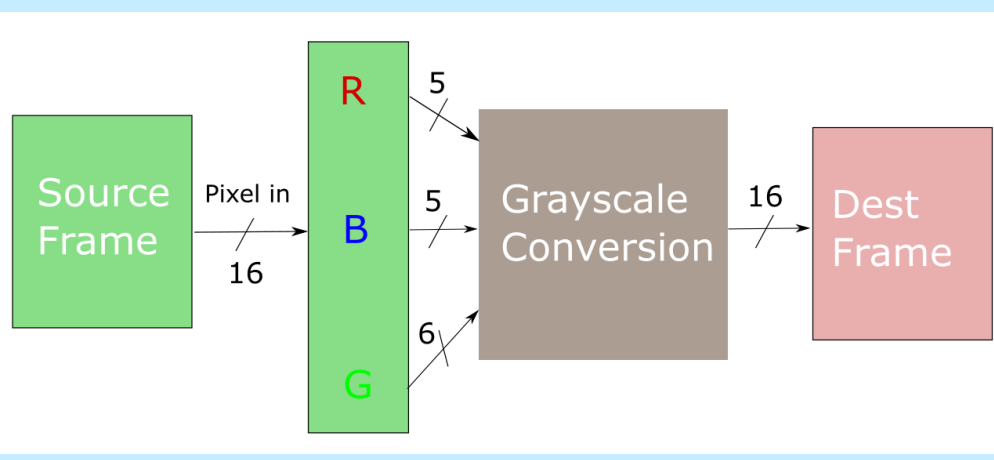
SDSoC makes it possible to only use C/C++ by implementing a hardware platform. This platform indicates which areas of the FPGA can be used by the program.



## Grayscale Conversion Filter

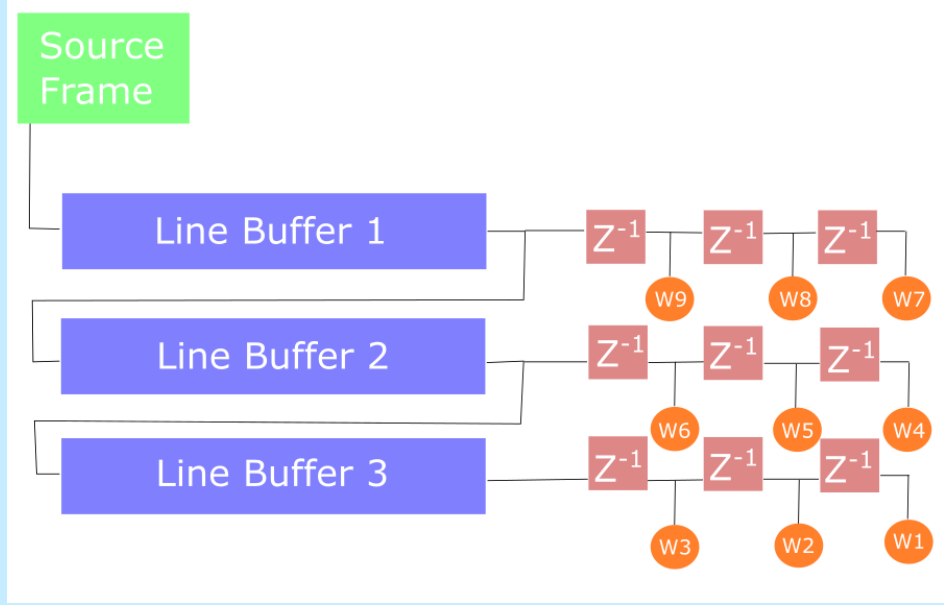
Grayscale filter operates by weighting each red, blue, and green colour in order to find an adequate gradient of grey. The filter uses the following function to do this calculation:

$$Y = R * 0.3 + B * 0.113 + G * 0.587$$



## Sobel Filter

The Sobel filter, developed by Irwin Sobel, is a filter that displays the gradient of an image. The sharper the gradient the whiter the colour.



Gx	=	<table><tr><td>-1</td><td>0</td><td>-1</td></tr><tr><td>-2</td><td>0</td><td>-2</td></tr><tr><td>1</td><td>0</td><td>1</td></tr></table>	-1	0	-1	-2	0	-2	1	0	1
-1	0	-1									
-2	0	-2									
1	0	1									
Gy	=	<table><tr><td>1</td><td>2</td><td>1</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>-1</td><td>-2</td><td>-1</td></tr></table>	1	2	1	0	0	0	-1	-2	-1
1	2	1									
0	0	0									
-1	-2	-1									

$$Gmag = |Gx| + |Gy|$$

