Lab 8: VGA Display

Due: 18:30, November 29, 2016

Objective

- To be familiar with how to show image on VGA display.

Action Item

1. Modify the Verilog code introduced in class to design a circuit for controlling the VGA display. The controller has the following input ports:

```
input   clk;
input   reset;
input   en;
input   dir;
```

and the following output ports:

```
output  [3:0]vgaRed;
output  [3:0]vgaGreen;
output  [3:0]vgaBlue;
output  hsync;
output  vsync;
```

The behavior of the circuit is explained below.

- At the beginning or when pressing the **reset** button, the VGA display will show the image (e.g., kanahei.jpg) at the origin position. It will stay still until the **en** button is pressed.

- The image will start/resume scrolling left or right in a column-by-column manner under the frequency of clk divided by 2^{22} (i.e., clk/2^{22}), or pause, depending on whether the number of the **en** button pressed is odd or even. The scrolling direction of the image is determined by dir input. If dir is 0, the image will scroll left. If dir is 1, the image will scroll right.

More details about the I/O signals of the circuit are given below.

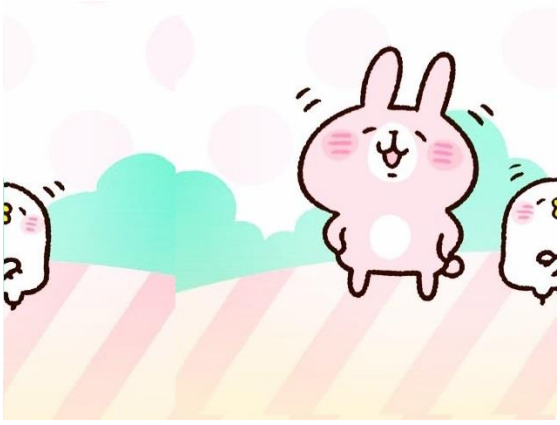
- **clk:** clock signal (connected to pin **W5**)
- **reset:** asynchronous positive trigger reset (connected to **BTNC**)
- **en:** pressing the button odd times to start/resume scrolling, and even times to pause scrolling. The number of times of pressing the **en** button will be re-counted from 0 every time after pressing the **reset** button (connected to **BTNU**)
- **dir:** signal to control the scrolling direction. If the dir switch is 0, the image will scroll left. If the dir switch is 1, the image will scroll right. (connect to **SW0**)
- **vgaRed:** 4 bits to represent the intensity of red color (connected to pin **N19, J19, H19, G19**)
- **vgaGreen:** 4 bits to represent the intensity of green color (connected to pin **J18, K18, L18, N18**)
- **vgaBlue:** 4 bits to represent the intensity of blue color (connected to pin **D17, G17, H17, J17**)
- **hsync:** the horizontal synchronization signal to tell the VGA display to refresh next row of 640 pixels (connected to pin **P19**)
- **vsync:** the vertical synchronization signal to tell the VGA display to start displaying a new frame (connected to pin **R19**)

Here are some example operations of the controller:

at the begining
or pressing **reset**

set **SW0** = 1, press **en**
➔ start to scroll right

(100 columns scrolled right)



(200 columns scrolled right)

: : :

(400 columns scrolled right)

press **en**
➔ pause

(still 400 columns scrolled right)

set **SW0** = 0, press **en**
➔ resume to scroll left

(400 columns scrolled right and 100 columns scrolled left)