

## Project Objective

In this project, we will cover three important tasks:

1. Executing image rotation on FPGA
2. Measuring system performance.

## Rotation Requirements

- a. Use the platform designer from Project 4, but only remove the mode component.
- b. Remove the display and resize code from your application and include the rotation image which is provided in the presentation L.7.
- c. Rotate the image four times on four angles (0, 90, 180 and 270 degrees).

## Performance Requirements

- a. In the platform designer, add **the interval timer and set its period to 100 and units to  $\mu$ s**, and keep any other settings as default. Connect the component with the processor and clock sources as you connected the JTAG UART (including the interrupt IRQ signal).
- b. **Set the priority of the timer component as 0 and the priority of the JTAG UART as 16** as explained in the lecture.
- c. Add the **system ID peripheral** and keep its features as default. Connect the component to the processor and the clock sources as you connect the JTAG UART.
- d. Then, re-generate the system, recompile quartus project, and configure the board.
- e. Open the application project in eclipse. Right-click on the BSP directory, go to Nios II and select Nios II editor. Set the following features, then regenerate the BSP.

Sys_clk_timer	Timestamp_timer	stdin	stdout	stderr
Timer_0	none	jtag	jtag	jtag

- f. In the application directory, open the main (or hello\_world.c) program. Add the following header file:

```
#include <sys/alt_alarm.h>
```

- g. Measure the time (number of ticks) required to execute the frame time. To do that you will need to use the code below. Also, use ticks\_example posted in Module 6 as your reference.

```
int ticks_per_second, ticks_start, ticks_end, frame_ticks;
unsigned long long duration;

ticks_per_second = alt_ticks_per_second();

ticks_start = alt_nticks();

frame_function();

ticks_end = alt_nticks();

frame_ticks = ticks_end - ticks_start;

duration= (unsigned long long) ticks_total / (unsigned long long) ticks_per_second;
printf("Total duration %llu seconds \n\n", duration);
```

## Project Report (70%)

The project report will be graded out of 100, and the points will be distributed as following:

**1.0** (20 points total, each value is 5 points) After you compiled and synthesized your system (without the timer), read the summary report from Quartus, and fill out the below table with the numbers from the report.

Logical Elements	Registers	Total Pins	Memory Bits

**2.0** (20 points total, each value is 5 points) After you compiled and synthesized your system (with timer), read the summary report from Quartus, and fill out the below table with the numbers from the report.

Logical Elements	Registers	Total Pins	Memory Bits

**3.0 (15 points)** Briefly, compare the results of Table.1 and Table.2.

**5.0 (5 points)** Run the application project on case 2 and calculate the frame rate in seconds and put the value in the table below. Note,  $frame\ rate = \frac{number\ of\ frames}{frametime}$ .

### Project Demo (30%)

- ✚ The main purpose of the demo is to test your project functionality and execution.
- ✚ Demos will be checked and graded by the TA.
- ✚ Demos will be graded out of 100, but worth 20% of total project grade.
- ✚ Both partners must show up in that day. If a member didn't show up, he/she receives 0 unless an excused absence was provided.
- ✚ Demos will be conducted during the lab time on the following dates:
  - **Section 001:** Wed. March 29<sup>th</sup>
  - **Section 002:** Fri March 31<sup>th</sup>
  - Demo dates will be decided by the groups.
- ✚ Below are how the demo points will be distributed.

Tasks	Point
Rotation by 0	/25
Rotation by 90	/25
Rotation by 180	/25
Rotation by 270	/25

### Project Submission

1. Save the project report as **r5\_username1\_username2.pdf**.
2. For this project, you are required to submit only the project report (No project submission is required). Submission date is **Tuesday March 28<sup>th</sup> by midnight.**
3. **Only one attempt** is allowed.
4. **Only one group member** can submit the report.