Project Objective

In this project, you will continue learning about the parallel I/O devices and the focus will be on the 7-Segments devices.

Project Requirements

a. Remove the decoder_output, system-counter and random_pattern components from your nios_system.

b. Keep the system_modes and decoder_inputs and any other components (clock source, nios processor, onchip memory and and jtag uart) in your system.

c. Change the name of the decoder_inputs into _rotation_inputs_ and rename the conduit signal as _rotation._ Keep other features (direction and width) same as we used in Project2.

d. Then, add _eight_ new PIO components to your system which represent the eight 7-segment in FPGA board. Table.1 shows the components' features that you need to set it up.

   The first column shows that I/O pins that will be used in the Verilog code and connected with the exported signal of your nios system. The second and third columns show the PIO direction and width respectively that you need to specify when you select the component from IP Catalog. The fourth column shows the name that you need to rename the component with when you add it to your nios system. The fifth column shows the signal name that will be exported in the conduit signal.

e. Connect the new added components to nios processor and clock source as you connected JtagUart component in Project2.

f. The Verilog code with the update is attached with the assignment in blackboard.

g. You are required to write an application software that executes the functions described in Table.2 based on the values of the system mode as explained in the table.

Table 1: Hardware Settings

PIO board device	Direction	Width	name	Conduit name
HEX0[7:0]	output	8-bit	segment0	seg0
HEX1[7:0]	output	8-bit	segment1	seg1
HEX2[7:0]	output	8-bit	segment2	seg2
HEX3[7:0]	output	8-bit	segment3	seg3
HEX4[7:0]	output	8-bit	segment4	seg4
HEX5[7:0]	output	8-bit	segment5	seg5
HEX6[7:0]	output	8-bit	segment6	seg6
HEX7[7:0]	output	8-bit	segment7	seg7

Table 2: Software Functions

System Mode	SW [1:0]	Function
0	00	All eight 7-segments must light up
1	01	A counter starts incrementing from 0x0000 to 0xFFFF, and the value displays on <u>first four</u> 7-segments. If the mode changes, the counter stops on latest number. If the mode changes back to 1, the counter restarts. Set counter display_speed to 100ms (or 100µ)
2	10	A random pattern starts, and the value displays on the fifth and the sixth seven-segments. If the mode changes, the pattern stops on latest value. Set the random_speed to 100ms (or 100µ)
3	11	Rotation of light is enabled. The rotation displays on the seventh and eighth seven-segments based on the rotation_inputs, SW [4:2]. See the explanation below.

h. Rotation of light is the status when the light circulates on the two 7-segments (seg6 and seg7) without going through the middle segment (G) and half of the segment as shown in Figure1.

i. The rotation direction will be either clockwise or anti-clockwise based on the rotation_inputs value. If rotation_inputs is 1 (SW[2] is ON), the rotation is clockwise. If the rotation_input is 2 (SW[3] is ON), the rotation is anti-clockwise.

j. The circulation occurs in two different speeds based on SW[4] value.

       1. If SW[4] is ON, the speed is *300ms*.
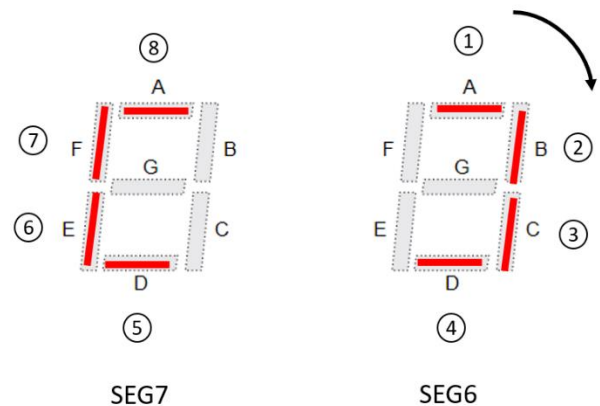   2. If SW[4] is OFF, the speed is *125ms*.

Figure 1: Rotation clockwise when rotation_input is 1

Project Report (70%)

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

a. **Professional preparation** (10 points):

You are required to submit a typed document with text of the paragraphs in Times New Roman 11 pt font, clear and grammatically well-formed explanations, page numbering and document heading numbering (1.0, 2.0, 3.0, etc to identify the required sections listed below).

b. **Report Content** (90 points):

1.0 (*20 points total, each value is 5 points*) After you compiled and synthesized your system, 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 (*30 points*) Briefly, compare the hardware results between the table above and Table.1 of project 2.

3.0 (*50 points*) Answer the following questions:

1. (*10 points*) What is the maximum width that the PIO components can have and why?
2. (*5 points*) What is the hardware the function that is used to display the value 0x55 on LEDs?
3. (*5 points*) What is the total number of I/O pins that is used in a system which includes four seven-segment and four push button switches, in addition to clock and reset?
4. (*10 points*) Describe the HAL layer.
5. (*10 points*) What is the difference between SoC chips and Standalone chips?
6. (*10 points*) There is two identical NIOS systems (A and B). After compiling both systems, the compilation report shows that number of LEs consumed for System A is smaller than number of LEs consumed for System B.

Based on your knowledge, which one of the given answers could be the reason?

    a. Nios II/e processor for B, and Nios II/f processor for A

    b. Nios II/e processor for A, and Nios II/f processor for B

    c. Nios II/e processors both A and B

    d. Nios II/f processors both A and B

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 30% of total project grade
- <u>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.</u>
- Demos will be conducted during the lab time on the following dates:
  - o **Section 001**: Wed. March 2nd or Wed. March 16th
  - o **Section 002**: Fri March 4 or Fri. March 18th
  - o Demo dates will be decided by the groups
- Below are how the demo points will be distributed

Tasks	Point
Mode 0 operation	/25
Mode 1 operation	/25
Mode 2 operation	/25
Mode 3 operation	/25

Project Submission

1. Save the project report as **r3_username1_username2.pdf**, username of both students in the group.
2. For this project, you are required to submit only the project report (No project submission is required). Submission date is <u>Sunday March 6th by midnight.</u>
3. **Only one attempt** is allowed
4. **Only one group member** can submit the report
5. **Remember:** Any grade dispute must be raised within one week of the grade posting.