CDA 4203 Sec 001

Spring 2022

Computer System Design

Mini-Project: Simple Digital Camera Design

Due: 11:59PM, Wednesday, 6th April 2022

Submission only by Canvas

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| --- | --- |
| Today’s Date: |  |
| Team Member Names:  Your U Numbers:  (Up to 3 members per team) |  |
| Work distribution | *Briefly explain each team member’s contribution. Grade for each member depends on their contribution to the project.* |

**Feedback:** Your feedback is extremely important to improve the mini-project for future course offerings.

|  |  |
| --- | --- |
| Total number of  person hours spent: | *Estimate the number of hours spent by each team member and add the numbers.* |
| Exercise difficulty:  (Easy, Average, Hard) |  |
| Issues you ran into: | *List all problem/issues you faced while doing this project.*  *(please use bulletized list)*   * *xyz* |
| Any suggestions to improve this project: |  |
| Any other feedback: |  |

**Part A**

**Front End Interface Design**

1. **(1 pt.)** Specification Analysis: Analyze the design specification and identify all requirements. What additional features would you like to see in the camera? (Maximum 1 Page)

Design Requirements:

* Camera lens to capture the photos
* Data bus between camera lens and camera controller/memory
* Programmable Controls: Gain, frame rate, frame size
* The resolution of the image should be at-least 1,024H x 1,024V (~1 million pixels).
* Buttons to control when snapshots are taken, when memory is cleared, and when continuous photos/video are taken (iffy on this one).
* Some form of volatile memory as a buffer between memory and any successive photos taken after the first photo (SRAM ideally).
* Internal flash memory to hold multiple pictures (At least 4 GB).
* USB port to interface with PC
* Total cost < $200

Additional Features (if possible):

* External memory card
* Ability to take video

1. **(1 pt.)** Read the datasheet and analyze the sensor array features**.** Summarize the **features of the sensor array relevant to your design**. *(Maximum 1 page)*

MT9M001C12STM Key Features:

* Array Format (5:4): 1,280H x 1,024V (1,310,720 active pixels). Total (incl. dark pixels): 1,312H x 1,048V (1,374,976 pixels)
* Frame Rate: 30 fps progressive scan; programmable
* Shutter: Electronic Rolling Shutter (ERS)
* Window Size: SXGA; programmable to any smaller format (VGA, QVGA, CIF, QCIF, etc.)
* Max data rate: 48 MHz
* ADC Resolution: 10-bit on-chip
* Supply Voltage: 3.0V-3.6V; 3.3V nominal
* 325mW active use, 275mW on standby

1. **(1 pt.)** Define the port interface of the Camera controller block. Briefly describe the purpose of each port. *(Maximum 1 page)*
2. **(2.5 pts.)** Analyze and define the timing interface required between the Pixel Array and Camera Controller blocks. *(Use as many pages as needed)*
3. (**2.5 pts.)** Implement an RTL design satisfying the port and timing interfaces determined in Questions (3) and (4). For the controller, you can stop at the state diagram.

*(Use as many pages as needed)*

1. **(1 pt.)** Draw a detailed schematic of the partial design of the front-end as well as user interfaces. Identify any other components that are required (for example, crystal-controlled oscillator). Show these components as well in the schematic. *(Maximum 1 page)*
2. (**1 pt.)** Estimate: (a) how long it will take for one image capture; and (b) the approximate dollar cost to implement the front-end interface. *(Use as many pages as needed)*

**Part** B

**Memory & PC Interface Design**

1. (1 pt.) Memory Component:

Choose an off-the-shelf memory component that can be used as internal memory for the camera. List the memory components that you have researched and provide arguments for your memory choice.

1. Flash memory: Can be programmed and erased electronically which is important for deleting pictures from the camera, and they do not need to be removed from the camera to be erased. Specific content from the memory can be erased as opposed to a complete clear, if only specific images are to be deleted.
2. **(1 pt.) Memory Component Features:** Read the datasheet of the selected memory component and briefly summarize its features.

27SF010 1024K 90ns CMOS Flash Memory

27SF010 Key Features

* Organized as 32K x8 / 64K x8 / 128K x8 / 256K x8
* 4.5-5.5V Read Operation
* Superior Reliability
  + Endurance: At least 1000 Cycles
  + Greater than 100 years Data Retention
* Low Power Consumption
  + Active Current: 20 mA (typical)
  + Standby Current: 10 µA (typical)
* Fast Read Access Time
  + 70 ns
  + 90 ns

1. **(1 pt.) Port Interface:** Define the port interface of the memory with the camera controller. Briefly describe the purpose of each port.
2. **(1 pt.) Timing Interface:**

Analyze and define the timing interface required between the memory and the rest of the system.

1. **(2 pts) Port and Timing Interfaces:**

Extend your design (developed in Part A) to implement the port and timing interfaces determined in Questions B.3 and B.4. For the controller, you can stop at the state diagram.

1. **(1 pt.) Detailed Schematic:**

Extend the detailed schematic of your partial design (developed in Part A) to include the memory. Identify any other components that are required. Show these components as well in the schematic.

1. **(1.5 pts) PC Interface**

Choose a suitable interface (serial/parallel/wireless) between the camera and PC such as USB, Bluetooth, etc. Suggest an off-the-shelf solution to implement this interface. You can “drop in” an existing design provided by the interface vendor. **You need not extend the camera controller for this interface. However, you should include the interface cost in your final cost estimation.**

1. **(1.5 pt.) Estimations**

Estimate: (a) the maximum number of images we can store in the memory; (b) the time required to store/retrieve one image; and (c) the approximate dollar cost to prototype the camera (excluding costs for PCB design and manufacturing, component soldering, and testing).