Computer Architecture: Homework 2

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Gaussian filter

- Gaussian function in two dimensions

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

- The 5*5 kernel used in this homework is as the following

$$\begin{bmatrix} 0.0039 & 0.0156 & 0.0234 & 0.0156 & 0.0039 \\ 0.0156 & 0.0625 & 0.0938 & 0.0625 & 0.0156 \\ 0.0234 & 0.0938 & 0.1408 & 0.0938 & 0.0234 \\ 0.0156 & 0.0625 & 0.0938 & 0.0625 & 0.0156 \\ 0.0039 & 0.0156 & 0.0234 & 0.0156 & 0.0039 \end{bmatrix}$$

Step by step

- Input : 128*128 array
  1. Padding (we use zero padding in this homework)
  2. Convert to double
  3. Do Gaussian filtering
  4. Convert the result back to **64-bit** integer
  5. Calculate RMSE between input and result

- Useful instructions
  - fcvt.d.l
  - fcvt.l.d
  - fadd.d
  - fmul.d
  - fsqrt.d

HW2.s

Data:

data_i	(128*128)	For input data
data_o	(128*128)	For output data
data_pad	(132*132)	For padding data_i
rmse_ans		For output rmse
buffer	(5*5)	For buffer
kernel_5	(5*5)	Gaussian filter

It is fine if you don’t use data_pad or buffer.

Requirement

1. (75%) Convolution data_i & kernel_5 with Gaussian filter and store it in data_o.
   - Zero padding is needed
   - Remember to convert data_i to double before you calculate convolution
   - Convert result to integer and store it in data_o

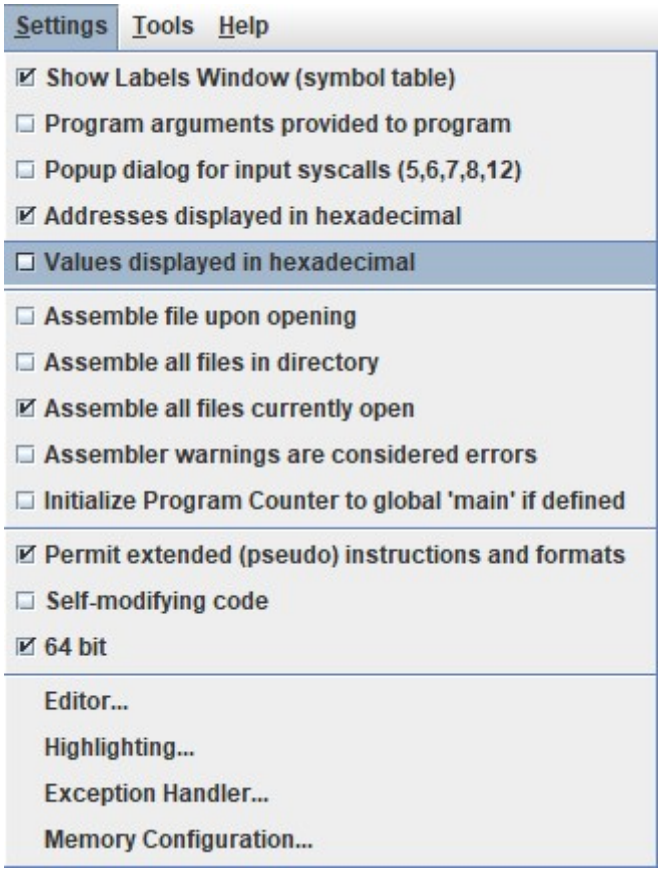
2. (25%) Calculate root mean square error (RMSE) between data_i & data_o (both in 128*128), and store the result in rmse_ans. Screenshot the console showing RMSE.

$$\sqrt{\frac{1}{m}\sum_{i=1}^{m}(y_i - \hat{y}_i)^2}$$

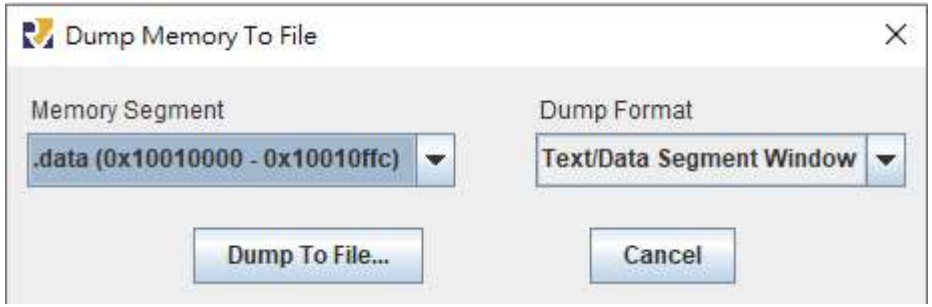
3. Dump memory in the decimal format to ans.txt
4. Briefly describe how you finish the work (padding, convolution, RMSE), it may help you get partial credits if your answer is not correct
5. (Option) Use smaller array provided in HW1 and implementation with other languages (C/C++, python) for debugging

Dump memory

1. Uncheck ” Values displayed in hexadecimal ”



2. File → Dump Memory



3. Filename: ans.txt

Submission

- Due: 2020/11/10 13:00 Tuesday (Upload to CEIBA)
- Format:
  - HW2_yourID.zip
    - HW2_yourID/
      - HW2.s (The assembly code)
      - ans.txt
      - RMSE.jpg (Screenshot of your RMSE output in double)
      - report.pdf (Briefly discuss your code)