Final Mini Project: Basic PPM Editor **Due date: 22 January, 2018**
Fundamentals of Programming **Total points 20**

PPM Image Editor

The PPM (or Portable Pix Map) image format is encoded in human-readable ASCII text. For those of you who wish to have the experience of reading real documentation, the formal image specification can be found here.

Sample ppm file

```
P3
        4  4
        255
        0   0   0     100  0   0          0   0   0      255     0  255
        0   0   0       0  255  175       0   0   0        0     0   0
        0   0   0       0   0   0         0  15  175       0     0   0
        255  0  255     0   0   0         0   0   0      255   255  255
```

Image Header

You can think of the image as having two parts, a header and a body. The header consists of four entries:

```
P3
        4  4
        255
```

1. P3 is a "magic number". It indicates what type of PPM (full color, ASCII encoding) image this is. For this assignment it will always be P3.
2. Next comes the number of columns and the number of rows in the image (4×4).
3. Finally, we have the maximum color value 255. This can be any value, but a common value is 255.
4. The way you see the header presented is how it should be spaced out.

Image Body

The image body contains the actual picture information. Each pixel of the image is a tiny, colored square. The color is determined by how much red, green, and blue are present. So, 0 0 0 is the first color of the image, which is black, and the last pixel in the image is 255 255 255, which is white. By varying the levels of the RGB values you can come up with any color in between.

Note that color values must be separated by a space, but after than additional whitespace is ignored by the image viewer. In the sample ppm above we used additional whitespace to format the image so that it is easy for a human to understand, but the computer doesn't care if everything is on one line, if there is one line per line of the image, or some mix (we will keep 1 line of text = 1 line of the image for this assignment to make the images easier to read in a text editor).

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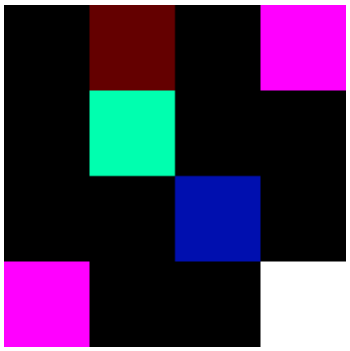
Putting it all together

The example image above would look something like this:



Keep in mind, each square is one pixel, so the real thing is much smaller (the rendered image was blown up by a couple of 1000%).

How to view PPM files

While PPM files are easy to view as text (you can use Notepad, for instance), and easy to work with in code, they are highly inefficient. Most modern image formats use some kind of compression to make their size reasonable while preserving the image appearance. This is not to say that PPMs don't still have some life in them–one modern use for PPM is an intermediate format when converting images from one type to another.

You will need to install a program to view these images on a Windows machine. Both Irfanview and XnView are small downloads and work quite well. It will also allow you to convert your own images to PPM so you can practice with pictures you took in the past (keep in mind that you may need to make them very small or the resulting PPM will be quite large!).

Your Assignment

Whew! That may sound like a lot of work, but it's really pretty simple. To make it easy to code up we've broken the program into three phases. In the first you are reading the whole image and writing it to a file without making any changes to the image in the process. Believe it or not, at this point you've written most of the program! In phase II we add some effects, and in phase III we add a menu for the user.

Phase I: Read/Write Images

The user will specify the name of the image file. The file will be a text file in PPM format as described in the discussion above. If the image file cannot be opened, the program should report that fact and abort the program.

The user will specify an output filename. The purpose of the program is to make an exact copy of the input file as the output file.

A picture of a normal size could easily become hundreds of thousands of numbers. You will not be able to read all of the image into memory at one time. So you have to deal with one piece of the file at a time. Consider a piece is held in a buffer array that is limited to only 3000 integers (would represent 1000 pixels). Obviously don't assume you will always read in a complete bufferful of data. Instead read in one ROW of the picture. Do you know how many pixels you have in one row? Yes, you do if you think about it. If the

header of the file tells you that the number of columns is larger than you can hold in the buffer, you should tell the user what is happening and abort the program.

Your output file can actually be formatted as you like. Whitespace includes newline characters, so you can put them in where you wish. The format allows for it.

Sample run.

```
+-----------------------------------+
| Portable Pixmap (PPM) Image Editor |
+-----------------------------------+

Enter name of image file: tinypix.ppm
Enter name of output file: tinypix_out.ppm

tinypix_out.ppm created.
```

And the output file created would be in a file called tinypix_out.ppm and would be identical to tinypix.ppm. Your program is NOT responsible for displaying the image in the file, just to manipulate the pixels and create an output file in the proper PPM format.

Test this with small files and large files. You can check to see if they are identical by loading them both into Notepad and comparing number by number.

Example ppm files can be downloaded here: ZIP Archive (1.2 MB) containing the following images:

1. cake.ppm - A picture of a slice of cake on a plate
2. squares.ppm - Some boxes
3. blocks.ppm - Some solid blocks of color
4. tinypix.ppm - The example image from above

Phase II: Basic Image Operations

- Write a function called “negate_red”. It will change just the RED color numbers into their "negative". That is, if the red number is low, it should become high and vice versa. The maximum color depth number is useful here. If the red were 0, it would become 255; if it were 255 it would become 0. If the red were 100, it would become 155. It should make changes to the buffer array as described above.

  When you have this function written, insert it into Phase I so that every pixel of the picture has had its red color negated in the output file. View this picture - does it look as you expected?

- Write a function called “flip_horizontal” which will flip the picture horizontally. That is, the pixel that is on the far right end of the row ends up on the far left of the row and vice versa (remember to preserve RGB order!).

- Write a function called “grey_scale” which will change the picture into a grey scale image. This is done by averaging the values of all three color numbers for a pixel, the red, green and blue, and then replacing them all by that average. So if the three colors were 25, 75 and 250, the average would be 116, and all three numbers would become 116.

- Write a function called “flatten_red” which will set the red value to zero. Write similar functions for the other color numbers.

In summary, you must implement the following functionality:

1. negate_red - Its job is to negate the red number of each pixel.
2. negate_green, as above but change the green
3. negate_blue, as above but change the blue
4. flip_horizontal that flips each row horizontally
5. grey_scale sets each pixel value to the average of the three
6. flatten_red sets the red value to zero
7. flatten_green sets the green value to zero
8. flatten_blue sets the blue value to zero

Phase III: Assembling the Basic Editor

The last part of the problem is to add a menu so that the user can decide which of these effects will be applied to an image.

Example of user interaction:

```
+-----------------------------------+
| Portable Pixmap (PPM) Image Editor |
+-----------------------------------+

Enter name of image file:  cake.ppm
Enter name of output file: outcake.ppm

Here are your choices:
   [1] convert to greyscale [2] flip horizontally
   [3] negative of red      [4] negative of green [5] negative of blue
   [6] just the reds        [7] just the greens   [8] just the blues

   Do you want [1]? (y/n)  y
   Do you want [2]? (y/n)  n
   Do you want [3]? (y/n)  y
   Do you want [4]? (y/n)  n
   Do you want [5]? (y/n)  n
   Do you want [6]? (y/n)  n
   Do you want [7]? (y/n)  n
   Do you want [8]? (y/n)  y

   outcake.ppm created.
```

You should apply the desired effects to the image one at a time.

Testing

Your input routine should avoid reading from a failed input stream. What if the file is not as large as the row and column numbers indicate it will be? Does your code handle that gracefully (without falling into infinite loops, for example)?

All your manipulations should NOT cause a color number to be less than 0 nor larger than the maximum color depth specified in the file.

Bonus

Implement up to 2 of these other functions. Each will be worth up to 2.5 points.

1. “horizontal_blur” which will take the values of the red numbers of three adjacent pixels and replace them with their average - note that this is different from greyscale! it also does the same with the greens and the blues of 3 adjacent pixels. Pixels on the edges will have to be handled specially.

2. “extreme_contrast" which will change each color number to either the highest color number possible or to 0. This change is based on whether it is greater than the midpoint of the color range, or less. If it is greater than half of the color depth, replace it with the colordepth. If it is less, replace it with zero.

3. “random_noise” adds a random number to each color number or subtracts a random number. It would have a parameter which would represent the size of the random number range; i.e. a value of 10 would add or subtract numbers in the range of 0 to 9, a value of 50 would add or subtract numbers in the range 0 to 49. Another random number would decide whether it was an addition or a subtraction. Remember that the values in the buffer should not exceed the colordepth nor get less than 0. You can use the extreme values instead.

Hand-in

This is a TEAM project. Form one with atmost 3 (three) people (team with single member is also allowed). Designate one member as the “team leader”, who will be responsible for the submission of the project.

Hand-in ONLY the files listed below at the appropriate location on the blackboard system at LMS. You should hand in a single compressed/archived file named Project_3_<your reg. No. XXX without angle brackets>.zip that contains the following files.

1. COMMENTED source files (ppmeditor.c) with author information at the beginning.

2. CLEAR snapshot of your console (SNAPSHOT.png) to show that your program is working.

3. PLAIN text file (OUTPUT.txt) that includes a) author information at the beginning, b) a brief explanation of the project, c) difficulties faced, and d) any comments, or suggestions.

The project will contribute a total of 5 (five) points out of the total 45 (forty five) points for the final ESE exam. Your programs will be graded on the following criteria:

1. **Program Specifications / Correctness.** does it compile? Are there obvious errors? Are there subtle errors? (25%)

2. **Documentation.** Is your program consistently indented in a manner that reflects the structure of your code? Is it easy to read? Are there blank lines which break up the major sections of your code? (15%)

3. **Efficiency.** Is your program efficiently organized, or is there a lot of duplicated code? Does it look well-written, or barely finished? (5%)

4. **Project Specifications.** Does your program fulfill the basic requirements? Is it done? And what else does it do? (15%)

5. **In time.** (10%)
6. **Plagiarism.** (30%)

Honor code

The student should agree to the terms below; any infringements will result in minimum marks.

- will not cheat on project
- will not share solutions to the project; and
- will notify the instructor immediately if he or she becomes aware of any other group cheating

References

PPM Image Format