

## CMPE 252 C Programming, Spring 2021

### HOMEWORK 3

**Due Date: 04.06.2021, Friday, 23:59**

**This is an individual work. No team work is allowed.**

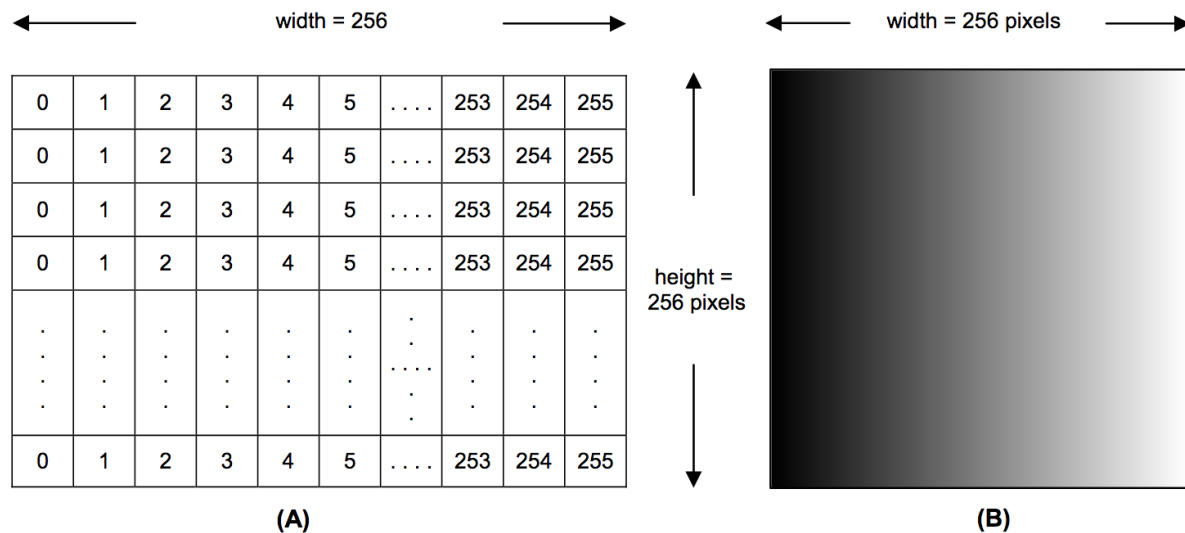
**Similarity check will be applied to submitted codes.**

#### **Background Information:**

A digital image can mathematically be considered as a function of 2 variables (e.g.,  $f(x, y)$ ). These 2 variables represent spatial coordinates (i.e., width and height) of the image. The value of the function at a specific coordinate (e.g.,  $(x, y)$ ) is called an intensity value or a pixel value.

Left part of Figure 1 given below shows the grid presentation of the grayscale intensity values (i.e., ranging from 0 (black) to 255 (white)) of the black and white monochrome image (i.e., greyscale) given on the right. As can be seen from the left part of Figure 1, an image can be considered as a 2 Dimensional (2D) array.

In order to organize and store digital images, image file formats which are standardized means are exploited. There exist varying image formats including png, jpeg, bmp, etc. The images are considered in one of these formats and the digital data they have are rasterized for the use in a computer display. The image is converted into a grid of pixels using the rasterization. Each pixel is associated with a number of bits to designate its grey value or color. The number of bits per pixel (bit depth) is considered while rasterizing an image for a given device. Bit depth or color depth represents the number of bits utilized to present the grey value or color of a single pixel.



**Figure 1:** Values in the grid represent the grayscale intensities of the image on the right.  
**(A)** Intensity values shown in a grid of same dimension as image **(B)** Image as seen on monitor

### Questions:

1. Write a C code namely **static.c** that can allocate memory for an image statically which means that the compiler knows the spatial coordinates during the compile time. Use `uint8_t` which is a signed integer type with width of exactly 8, 16, 32 and 64 bits, respectively, in the code. Note that `uint8_t` is used with `stdint.h` (15 points).
2. Write a C code namely **dynamic.c** that can dynamically allocate memory for a 2D image array, which means that the spatial coordinates of the image are not known during the compile time. However, they are known during the run time. Also use `uint8_t` type for this code as well (20 points).
3. Create a 2D array of size 14x14 having same values ranging from 0 to 255 in each row. You are free to specify the values of this array. For instance, consider a 3x3 array as;

Array [3] [3]= { { 12,12,12}, { 75, 75, 75}, { 247, 247, 247} }

12, 75, and 247 pixel values are specified in a way that they are in a range of 0 to 255 and they are same in a row.

Write a code namely **arraytoimage.c** using any pgm (portable gray map) format image that represents an image in a text file in which each pixel is represented by a number ranging from 0 and 255. In this code, write:

- P2 (magic number)
- Width and height of the image
- Maximum grayscale value

-Gray scale intensity values you specify in the array

in an order to this image (30 points).

4. Take a picture of your TEDU ID. You will use this picture as a grayscale image in any image format. Note that even though you can use any image format, bmp (bitmap) image format is preferable. Consider how the image formats structure an image while choosing and using your image format. Note that as a basic structure, image data is structured as:

-Image Header (including width, height, and bit depth of an image)

-Color Table

-Image Data

Considering all of the information given above, write a code namely **complement.c** that outputs the complement of the grayscale values that your input image pixels have. That means that if a grayscale pixel value is 2 in your image, it will become  $255-2=253$  due to the fact that the grayscale pixel values range from 0 to 255. Then display the output image (35 points).

**Notes:**

Even though all the necessary background information is given above, you may need to learn any required information while writing your codes.

**Grading:**

It will be based on your codes for the Questions 1 and 2; your codes as well as output images for the Questions 3 and 4.

Best of luck with your codes.