

**CS111: Fundamentals of CS**

**Assignment 4 (3 marks + 2 bonus) – Version 1.0**



Cairo University, Faculty of Computers  
and Information

## **FACULTY OF COMPUTERS AND INFORMATION, CAIRO UNIVERSITY**

### **CS112: Programming I Year 2017-2018 Second Semester**

**Assignment 4 – Version 1.0**

**Deliver ONE fully integrated program**

#### **Course Instructors:**

**Dr. Mohammed Al-Ramly  
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#### **Revision History**

<b>Version 1.0</b>	By Dr Mohammed El-Ramly	30 March 2018	Main Doc
<b>Version 2.0</b>	By Dr Mohammed El-Ramly	2 April 2018	Bonus added

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### Objectives

This assignment trains students on problem solving using C++ 2D arrays and using readymade library code, written by others for you to use into your program.

### Introduction

In this program, you will develop an image processing tool that can apply different filters (changes) to a given gray (and colored for bonus) bit map image of size 256 x 256. You are provided with the following to start your work:

- (1) A small library with four functions for loading the pixels of the image into a 2D or 3D array. The library consists of two files **bmplib.cpp** and **bmplib.h**. You need to include this line at the top of your program to include the library with your code. Put files **bmplib.h** and **bmplib.cpp** in the same directory as your code.

```
#include "bmplib.cpp"
```

The library has two constants defined for you to use in the program. These are:

```
SIZE = 256          // Represents image size of SIZE x SIZE. Needed for all images
RGB = 3             // Number of color bytes for colored images: 3 bytes=24 bits
                    // Needed only for colored images (bonus)
```

The functions available from this library are:

```
// Read pixels from a colored bmp image filename to a SIZE x SIZE x RGB array,
// for example (256 x 256 x 3), named inputImage
int readRGBBMP(const char* filename, unsigned char inputImage[][SIZE][RGB]);

// Write full-color image to the file specified by filename, from 3D matrix
// outputImage of size SIZE x SIZE x RGB, for example (256 x 256 x 3)
int writeRGBBMP(const char* filename, unsigned char outputImage[][SIZE][RGB]);

// Read pixels from a gray scale bmp image file specified by filename to a 2D
// SIZE x SIZE array, for example (256 x 256), named inputImage
int readGSBMP(const char* filename, unsigned char image[][SIZE]);

// Write a gray scale image to the file specified by filename, from 2D matrix
// outputImage of size SIZE x SIZE, for example (256 x 256)
int writeGSBMP(const char* filename, unsigned char outputImage[][SIZE]);
```

To see an image you need to open it outside the program with MS Photos or MS Paint.

- (2) You are also given a set of colored and gray images to test your program with. To see an image, open it with MS Photos or MS Paint.
- (3) Finally, you are given a small demo program demo2.cpp to show how to use the given functions to open and load an image. The demo does not apply any filters; it just stores the opened image in another file. Images must be in the same folder and directory where the program is. You enter the image name without .bmp.

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A pixel in a gray scale bitmap image is stored in one byte with a value between 0 =   and 255 =  . A pixel in a colored bitmap image is stored in 3 bytes representing Red Green and Blue values of the pixel's color ■ ■ ■. Each value is between 0 (color does not exit) and 255 (max value for this color)

You will develop a program that displays a menu of choices for the user continuously until the user chooses exit. The menu will allow the user to load an image and choose the filter to apply. The user can choose save to store the filter after specifying the name of the target file. The menu is structured according to this hierarchy. **Text in red is the user input.** Some menu options have more choices to select from.

Ahlan ya user ya habibi ☺

Please enter file name of the image to process:  
**elephant**

Please select a filter to apply or 0 to exit:

- 1- Black & White Filter
- 2- Invert Filter
- 3- Merge Filter
- 4- Flip Image
- 5- Darken and Lighten Image
- 6- Rotate Image
- 7- Detect Image Edges
- 8- Enlarge Image
- 9- Shrink Image
- s- Save the image to a file
- 0- Exit

Please enter name of image file to merge with:  
**photographer**

Flip (h)orizontally or (v)ertically ?

Do you want to (d)arken or (l)ighten?

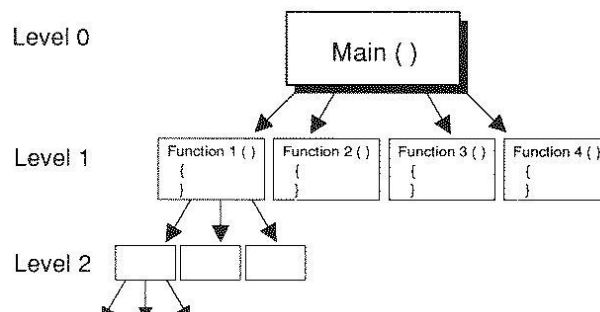
Rotate (90), (180) or (360) degrees?

Which quarter to enlarge 1, 2, 3 or 4?

Shrink to (1/2), (1/3) or (1/4)?

Please enter target file name:  
**elephantBW**

For your program, you should develop each filter in a separate function. Deliver a **system diagram** showing the **different functions** of the system and **their relation** to each other as shown in the figure below.



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### Instructions

1. It is very important to collect course work marks in order to pass easily and get a good grade. من المهم للغاية حسن أداء أعمال السنة لتتجح بسهولة و تحصل على تقدير مرتفع.
2. These instructions must be followed to get the full marks. يجب اتباع هذه التعليمات بكل دقة.
3. **Deadline for part 2 is Tuesday 11 April 2018 @ 11:59 pm.**
4. Students will form teams of three students **from the same lab group** whose IDs are not the same.
5. Please submit **only work that you did yourself**. If you copy work from your friend or book or the net **you will fail the course**. تسليم حلول منقولة من أى مصدر يؤدي إلى الرسوب فى هذا المقرر. لا تغش الحل أو تنقله من أى مصدر و تعالى و اسألنى فى أى شئ لا تفهمه نقل أى جزء و لو صغير من الكود من زميل أو أى مصدر أو إعطاء أى كود و لو قليل لأى زميل يعتبر غشا و يحصل صاحبه على سالب الدرجة.

### Task 1 (0 / -1 mark) – Group Task

Each team will develop together the **menu display** function and the **load** and **save functions**. They will work on their individual tasks and then **must integrate and test all the functions** of the program together. If they deliver separate programs not integrated ones, they lose one mark.

### Task 2 (3 marks) – Individual / Group Task

Each team member will develop 3 individual filters (tasks or functions). Team will divide the work as follows: the student with the smallest last digit in his ID does **filters 1, 4, 7**, the next does **filters 2, 5, 8** and the student with largest last digit in his ID does **filters 3, 6, 9**.

Student with ID 2017013**0** does **filters 1, 4, 7**

Student with ID 2017013**1** does **filters 2, 5, 8**

Student with ID 2017013**5** does **filters 3, 6, 9**

### Project: Gray Scale Image Processor

An image processing (or photo editing) software like Photo Shop allows you to load an image (like the photographer image here) and apply some changes (called filters) to image and then save it again.

يقوم برنامج معالجة الصور مثل الفوتوشوب مثلاً بتحميل الصورة المرغوبة وإتاحة مجموعة من العمليات تسمى المرشحات للتنفيذ على هذه الصور ، كل منها ينتج عمل تغيير فى الصورة ، و فيما يلى شرح للمرشحات المطلوبة و فى أعلام شرح كيف ستقسم على فريق العمل و ما نصيب كل عضو.



#### Filter 1: Black and White Image

If you apply this function to the loaded image, it will produce another version of the image that is black and white.

You can do this by calculating the average gray level for all pixels in the image. And then every pixel above the average is turned to white (255) and every pixel below average is turned to black (0).



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### Filter 2: Invert Image

If you apply this function to the loaded image, it will produce the negative of the image and you can store it in the file name you give.

The negative has every black pixel turned to white and every white pixel turned to black and every gray pixel is turned to opposite level of brightness ( $255 - \text{pixel value}$ ).

مرشح العكس: هذا المرشح يعكس الصورة و يعرض النيجاتيف.



### Filter 3: Merge Images

In this function, you will be asked to enter the name of another image. Then the program will load this image. The program will create a new image, with every pixel equal the average gray level of the corresponding pixels in the images to merge.

مرشح الدمج: سيحمل البرنامج صورة ثانية بجانب الصور التي حملها أولاً و سينشئ صورة كل نقطة فيها تمثل متوسط مستوى الرمادي في النقطتين المناظرتين في صورتين المدمجتين.



### Filter 4: Flip Image

This filter allows the user to flip the image horizontally or vertically, as if it is reflected on a mirror.

مرشح العكس: يتيح هذا المرشح عكس الصورة على مرآة أفقياً أو رأسياً بحسب اختيار المستخدم.



### Filter 5: Rotate Image

This filter allows the user to rotate the image clockwise by  $90^\circ$ ,  $180^\circ$  or  $270^\circ$  as the user chooses.

مرشح الدوران: هذا المرشح يدير الصورة باتجاه دوران الساعة  $90^\circ$  أو  $180^\circ$  أو  $270^\circ$  درجة.



### Filter 6: Darken and Lighten Image

This filter allows the user to make the image darker or lighter by 50%

مرشح الإضاءة: يتيح هذا المرشح تفتيح و تخفيف الصورة بنسبة 50% بمعنى زيادة أو تقليل إضاءة الصور بهذه النسبة.





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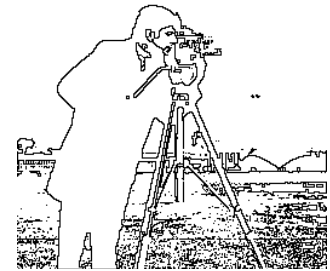
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### Filter 7: Detect Image Edges

This function finds the edges of the drawings in the image and turns the image into a skeleton version of the original as if it is drawn with pencil without coloring as shown.



### Filter 8: Enlarge Image

This filter allows the user to enlarge one of the four quarters of the image into a separate new image.

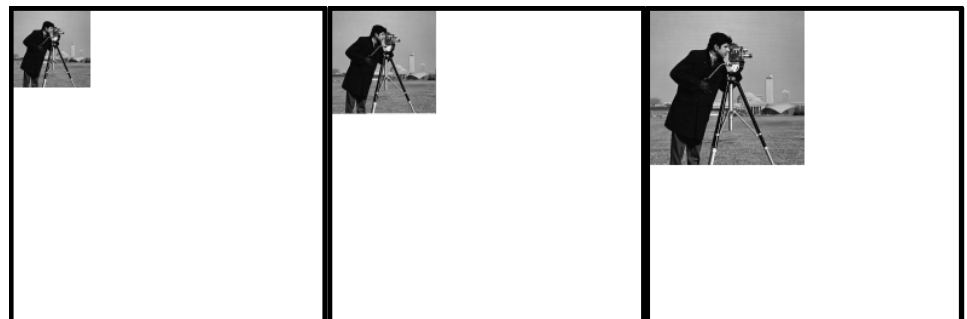
مرشح التكبير: هذا المرشح يسمح  
بتكبير أحد أرباع الصورة  
الأربعة إلى صورة مستقلة ٢٥٦  
في ٢٥٦ بكسل



### Filter 9: Shrink Image

This filter allows the user to shrink the image dimensions to 1/2, 1/3 or 1/4 the original dimensions.

مرشح التصغير: يتيح هذا المرشح  
تصغير الصورة إلى نصف أو ثلث  
أو ربع أبعادها الأصلية.



There is an online image processing tool that you can try here.

<http://pinetools.com/grayscale-image>

### Bonus Project: Colored Image Processor (2 marks)

This is a bonus project for the whole team. The will develop a similar program using the same library that does the same functions on **colored images**.

#### Team must:

- 1) **Develop the whole 9 functions**
- 2) **WORK TOGETHER and divide work equally**



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### How to Prepare and Deliver the Solution

#### Submitting the Solution

1. Team will submit into acadox the following:

**On Wed 11 April 2018**

- A zip file with the following called:

**CS112-2018-2<sup>nd</sup> –Group-YourID-YourID-A4.zip**

1. A cpp file with the source code of the whole integrated program. Name the file

**CS112-2018-2<sup>nd</sup> –Group-YourID-YourID-A4.cpp**

2. A pdf file with the function decomposition diagram called **and team names and IDs:**

**CS112-2018-2<sup>nd</sup> –Group-YourID-YourID-A4.pdf**

3. (Optional) A cpp file with the source code of the whole integrated bonus program:

**CS112-2018-2<sup>nd</sup> –Group-YourID-YourID-A4Bonus.pdf**

4. **DO NOT INCLUDE** **exe** files or **image** files or any other files

#### Coding Style

The program should follow proper coding style for C++ as shown below.

**1- Variable names must be in mixed case starting with lower case.**

line, savingsAccount

**2. The prefix *n* should be used for variables representing a number of objects.**

nPoints, nLines

**3. Iterator variables should be called i, j, k etc.**

for (int i = 0; i < nTables); i++) { : }

**4. The prefix *is* should be used for Boolean variables and methods.**

isSet, isVisible, isFinished, isFound, isOpen

**5. The conditional should be put on a separate line.**

if (isDone) // NOT: if (isDone) statement1;  
statement1;

**6. Block \*layout should be as illustrated in example 1 below (recommended) or example 2**

<pre>while (!done) {     doSomething();     done = moreToDo(); }</pre>	<pre>while (!done) {     doSomething();     done = moreToDo(); }</pre>
--	--

(Taken from <http://geosoft.no/development/cppstyle.html>)

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### Program Header

Each program should start with a header explaining what it is and who authored it. It should also have the date.

- لابد أن يحتوى كل برنامج على تعليقات وإيضاحات كافية و أن يبدأ بالتعليق التالى:

```
// FCI - Programming 1 - 2018 - Assignment 3
// Program Name:          xxxxxx.cpp
// Last Modification Date: xx/xx/xxxx
// Author1 and ID and Group:      xxxxx xxxxx
// Author2 and ID and Group:      xxxxx xxxxx
// Author3 and ID and Group:      xxxxx xxxxx
// Teaching Assistant:          xxxxx xxxxx
// Purpose:.....
```

### Academic Honesty Declaration

يملاً كل فريق هذا القسم و يقدمه مع التقرير للمعيد. TA. Each group should fill this form and submit with report to the TA.

جامعة القاهرة – كلية الحاسبات و المعلومات	
الفرقة الأولى – برمجة الحاسبات ١ – ٢٠١٨ - المسألة ٤	
اسم الطالب.....	Name..... التاريخ Date ..... المجموعة Group .....
اسم الطالب.....	Name..... التاريخ Date ..... المجموعة Group .....
اسم الطالب.....	Name..... التاريخ Date ..... المجموعة Group .....
<b>We give oath that we have fully authored all the programs we submitted for Assignment 4 and we did not copy work from the net, from other colleagues or from any sources.</b>	
نقسم بالله العظيم نحن الموقعون أدناه أننا قد قمنا بتنفيذ هذه المسألة Assignment 4 بأنفسنا و لم نغش مطلقاً أو ننقل جهد غيرنا للحصول على درجات بغير حق أو نعطي مجهودنا للآخرين بغير حق و الله على ما نقول شهيد (من يتخرج من صيغة القسم لسبب ديني يكتب ما يناسب معتقده)	
التوقيع Signature .....	التوقيع Signature .....
التوقيع Signature .....	التوقيع Signature .....

### Marking Criterion

- |           |  |
|-----------|--|
| 3 marks   | For every student for doing his 3 functions and working properly (1 mark / filter) |
| -1 mark   | If work is not integrated correctly in one full program                            |
| -0.5 mark | If not using good coding style and headers   |