LBYEC72 Final Project Overview

Mini-Image Processing Project

Melvin Kong Cabatuan

Objectives

- Introduce bitmaps and colour depth.
- Perform basic image operations, i.e. addition, subtraction, multiplication, etc.
- Convert RGB to Grey Scale Image.
- Provide a general overview in image processing in C using Cimg library.

Tools

- **DevC++ Compiler** - a full-featured Integrated Development Environment (IDE) for the C/C++ programming language.

  http://www.bloodshed.net/devcpp.html

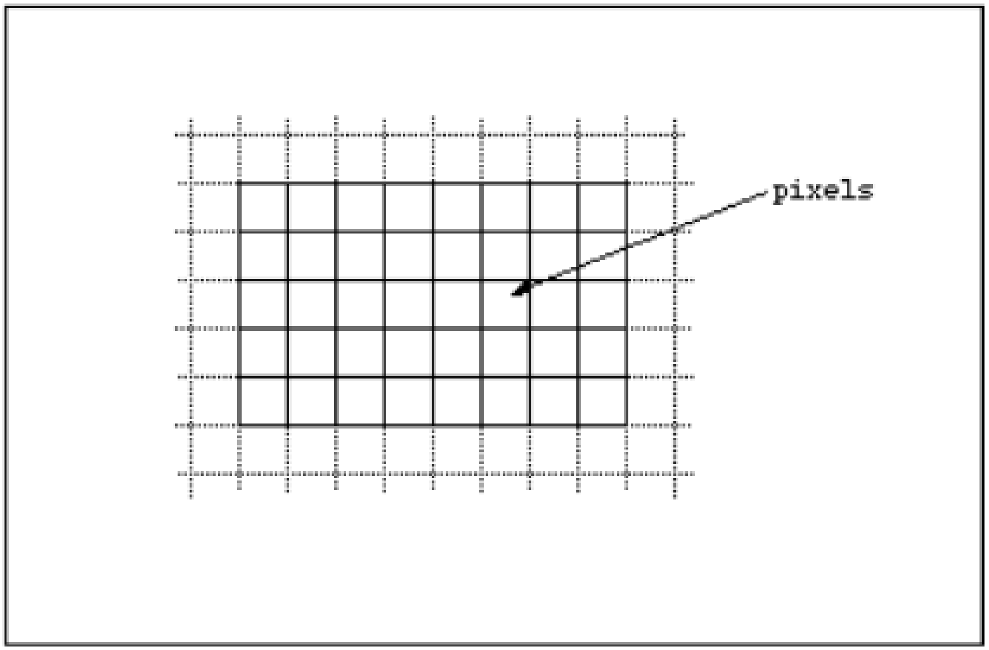
- **CImg library** - a small, open source, C++ toolkit for image processing. Choose CImg 1.2.5 version for compatibility with DevC++.

  http://cimg.sourceforge.net/news.shtml

- **Paint** - a simple graphics painting program that has been included with all versions of Microsoft Windows. We use this for editing pictures in 24 bit .bmp files. Note: You can use any other picture editing tool.

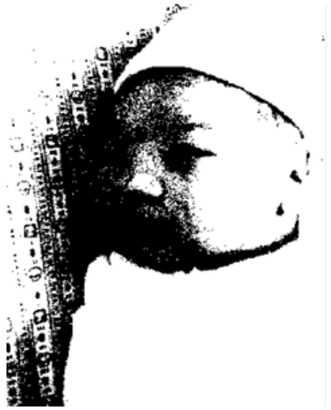
Introduction

- **Bitmaps** are defined as a regular rectangular mesh of cells called **pixels**, each pixel containing a colour value.

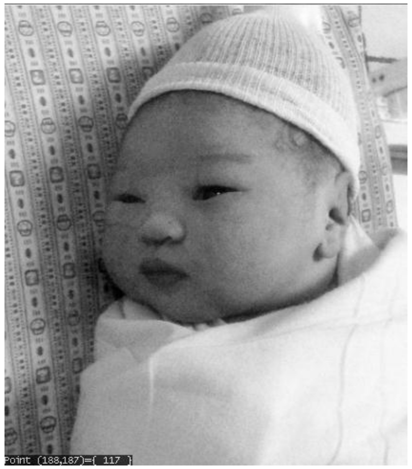


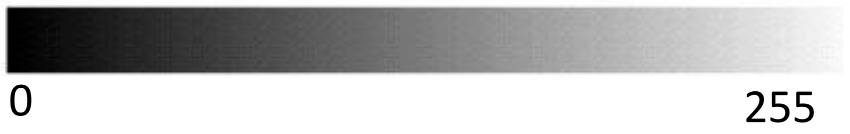
Colour Depth

- **1 bit (black and white)** – monochrome



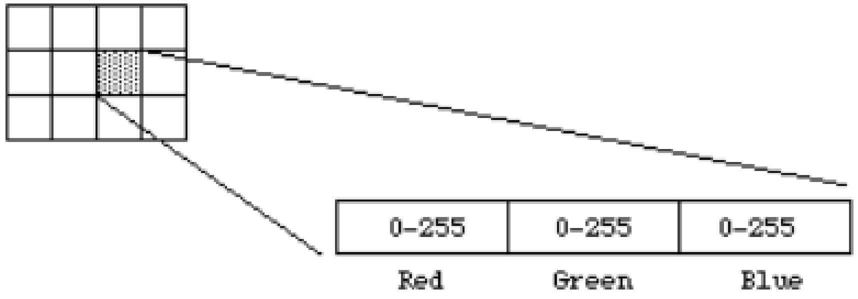
- **8 bit greys** - each pixel takes 1 byte (8 bits) of storage resulting in 256 different states.

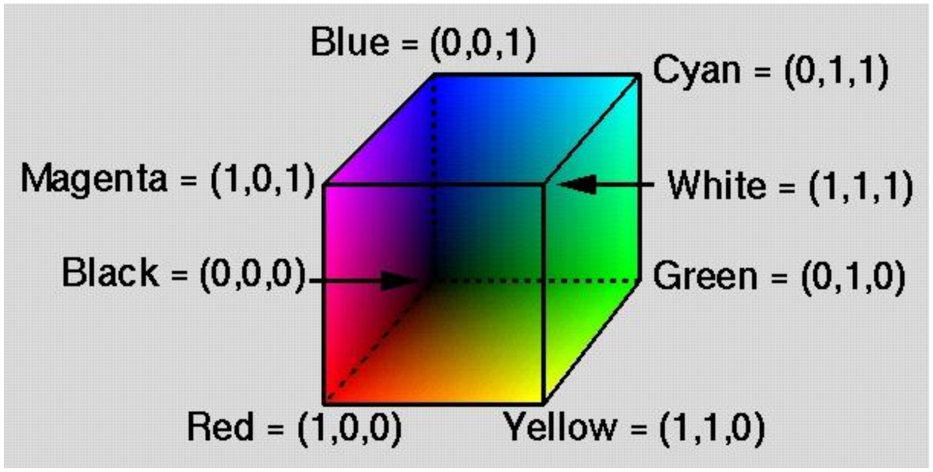




Colour Depth

- **24 bit RGB (true color)** - 8 bits allocated to each red, green, and blue component.





Example:

The height of the image is 24.
The width of the image is 28.

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99 184 194 197 200 219 228 136 151 158 82 91 87 47 66 67 49 67 66 40 50 48 19 25
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3 252 255 254 237 244 242 167 181 179 113 125 124 161 170 171 173 183 182 70 80
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 189 187 88 97 96 144 153 153 109 118 124 198 218 218 175 187 191 190 207 214 13
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 188 200 204 215 231 238 166 183 193 102 113 112 37 59 61 46 69 69 59 73 74 9 17
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189 205 209 228 246 252 202 221 222 181 187 192 193 212 214 152 161 170 107 118
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 84 255 254 255 255 255 255 142 151 150 30 42 43 15 24 23 19 28 27 16 22 23 9 13
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1 110 81 58 134 127 120 202 204 216 153 159 173 52 62 75 21 27 35 93 97 97 22 30
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 36 26 19 38 32 26 134 134 139 154 160 175 142 153 166 156 161 154 79 83 77 112
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Example:

The height of the image is 24.
The width of the image is 28.

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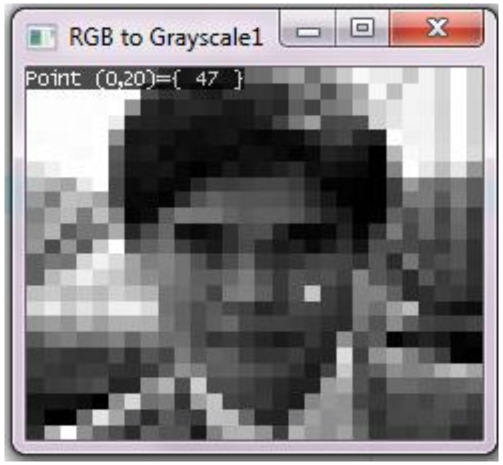
8 bit greys



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The height of the image is 24.
The width of the image is 28.

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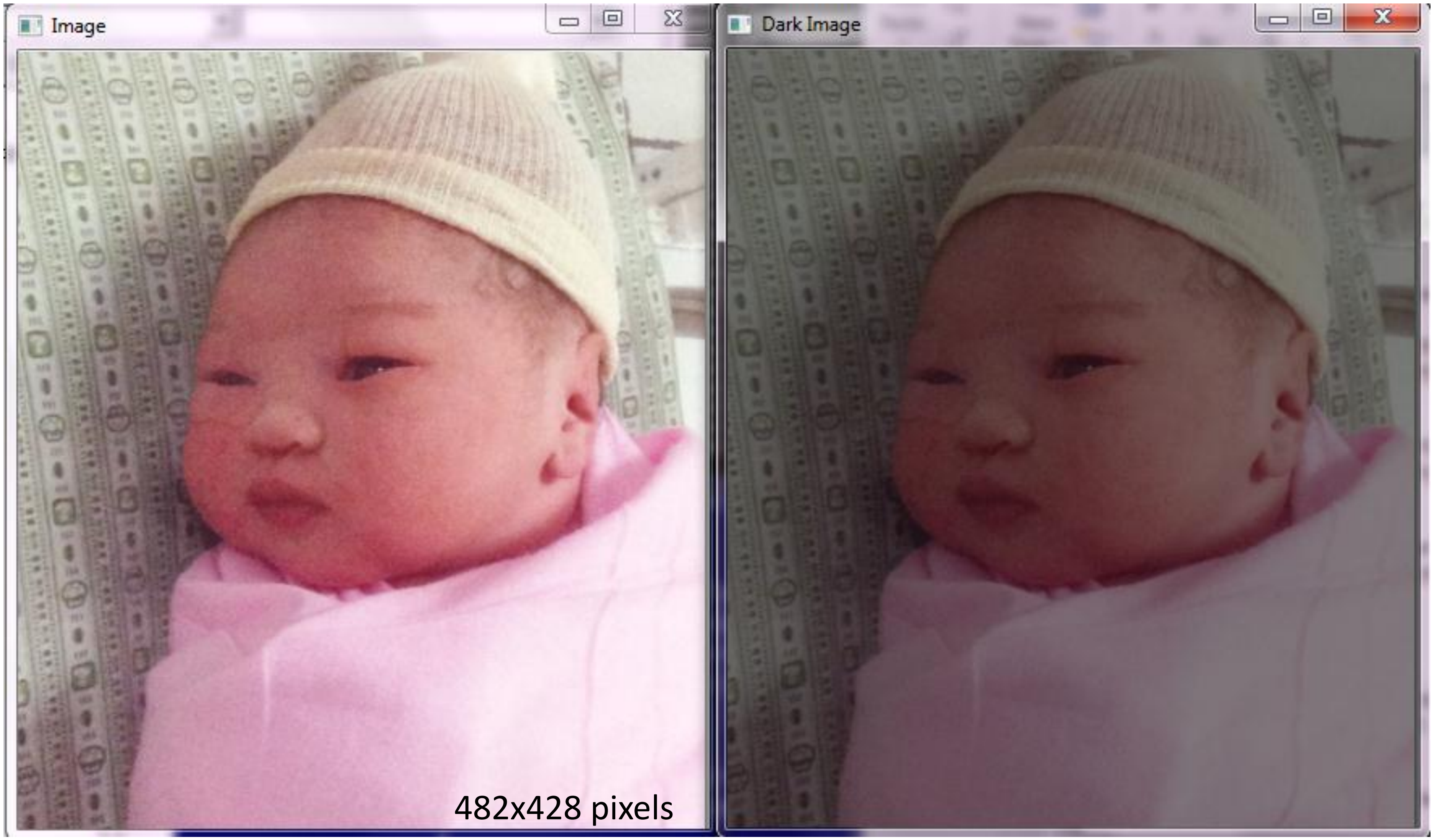
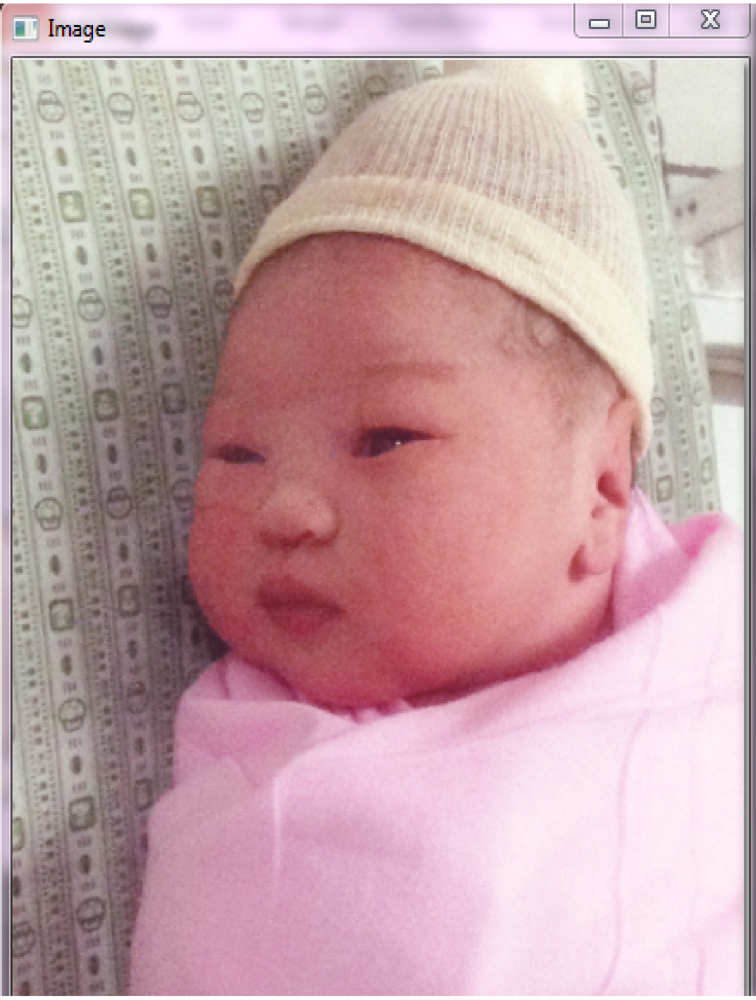
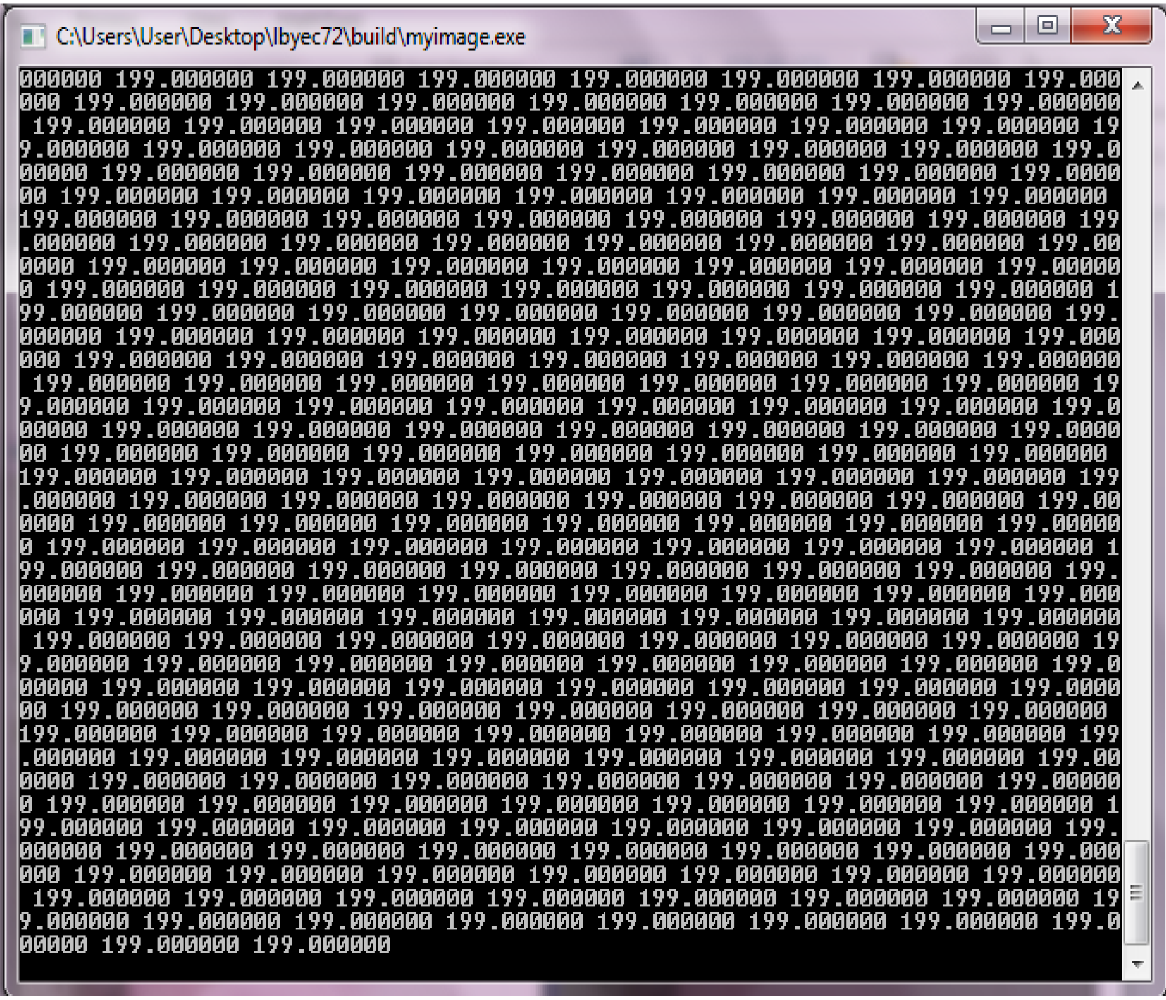
Simple Image Darkening



24 bit Bitmap Image (.bmp)

Original Image and its Array





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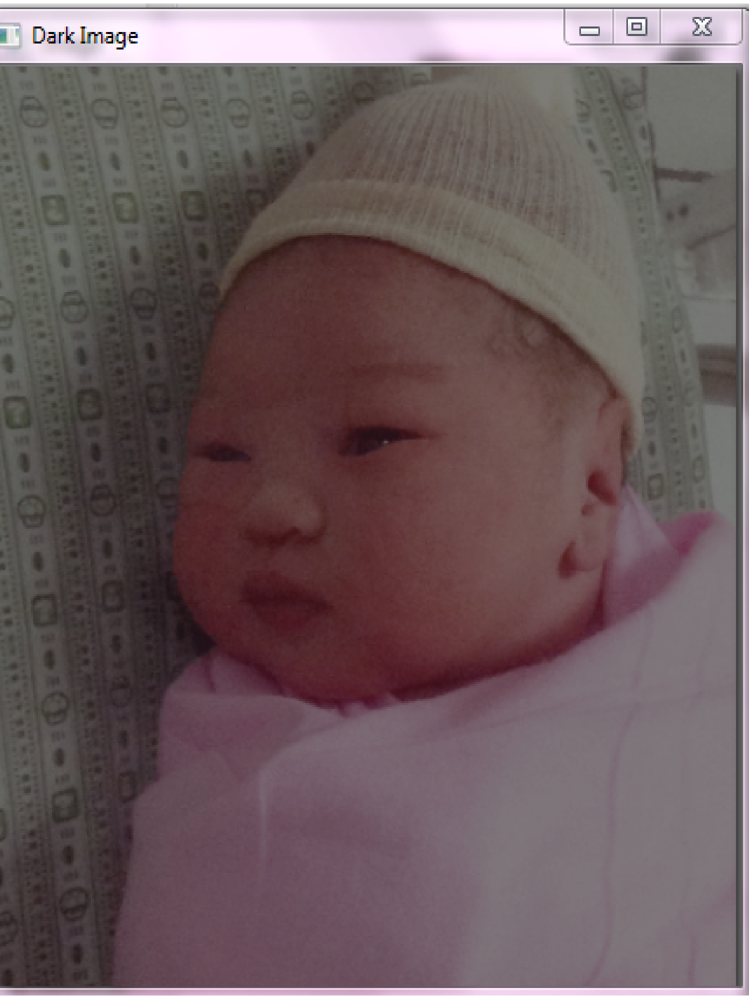
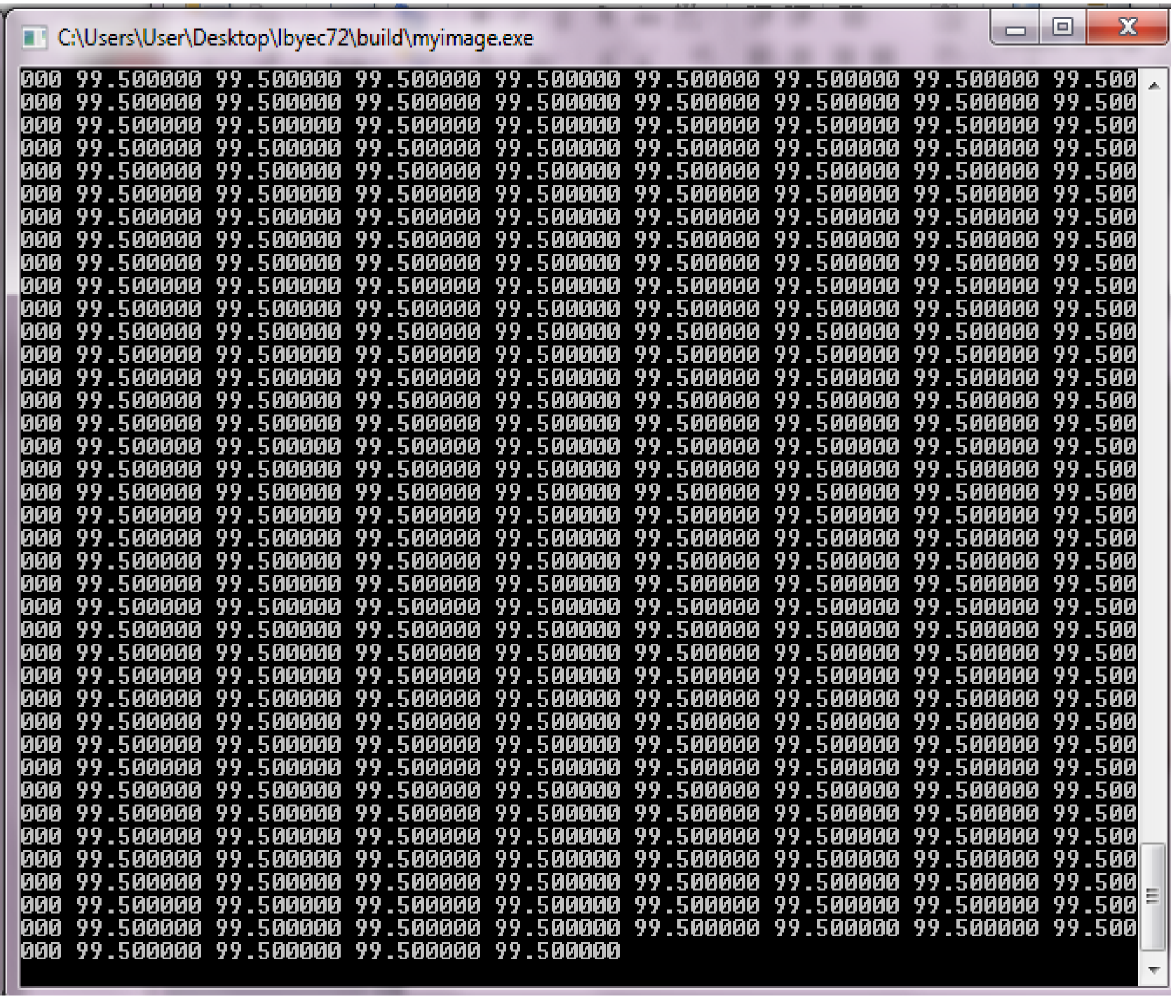
Dark Image and its Array





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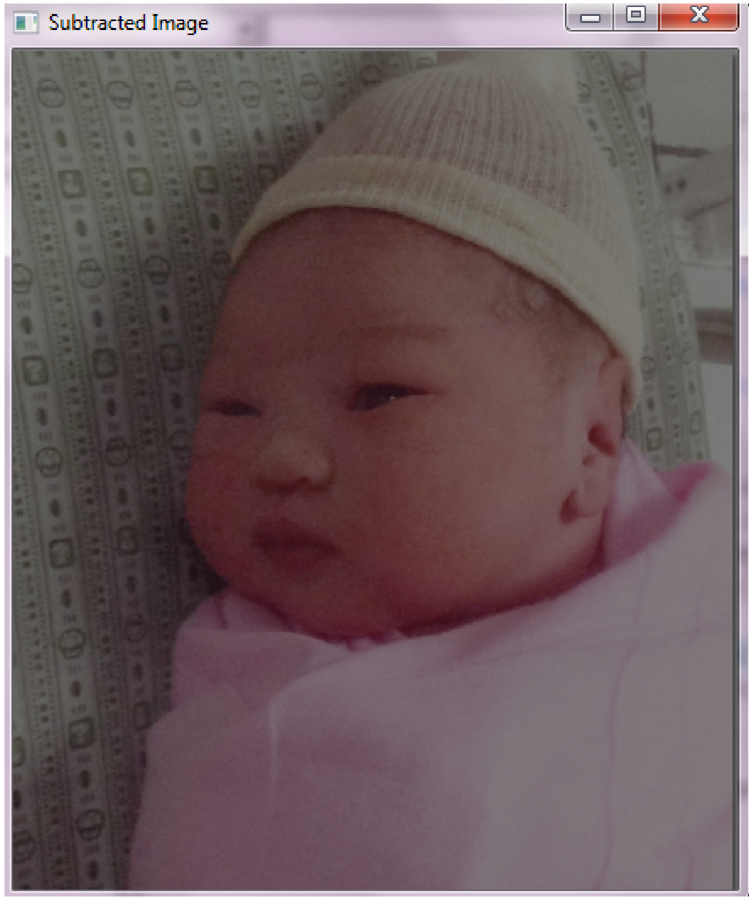
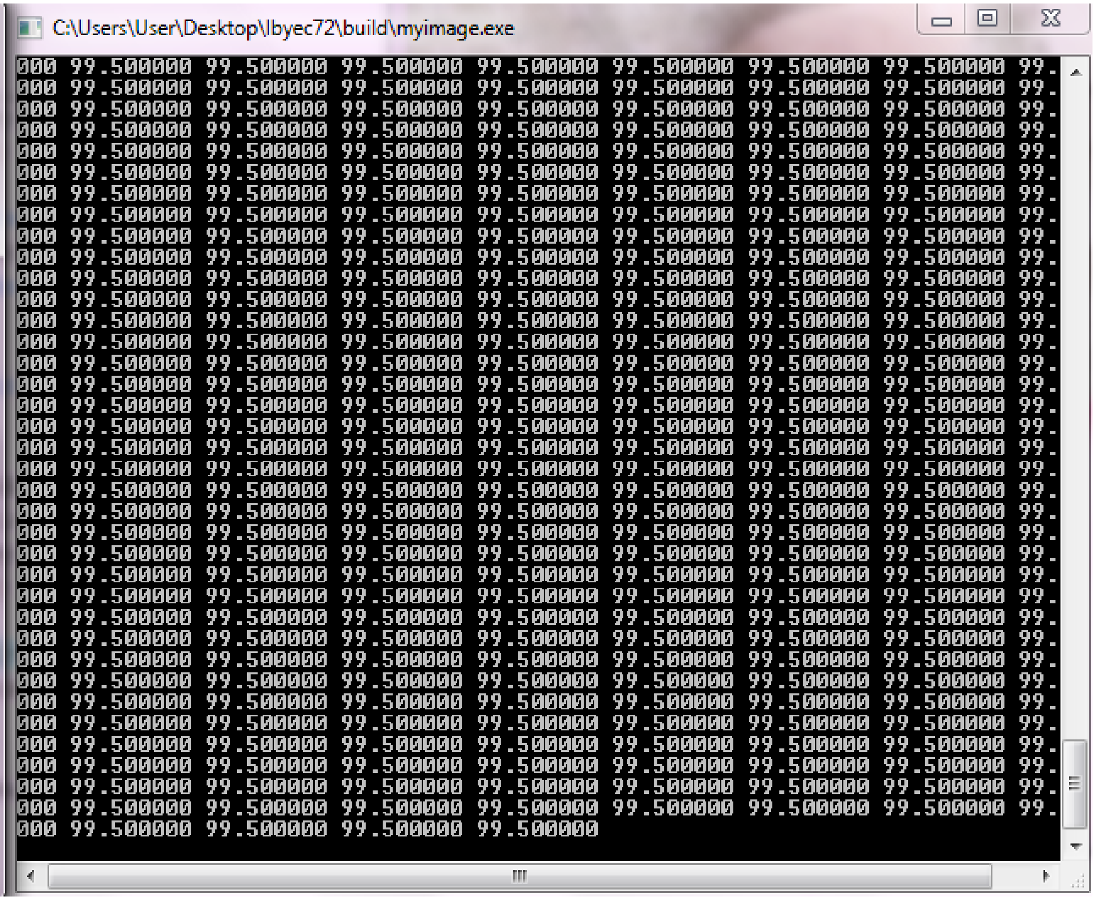
Source Code

```
#include <stdio.h>
#include <stdlib.h>
#include "CImg.h"
using namespace cimg_library;
int main() {
   CImg<double> image("img/baby2.bmp");     // load baby2.bmp image
   const unsigned int width = image.dimx();     //retrieve image dimensions
   const unsigned int height = image.dimy();    //retrieve image dimensions

   printf("The height of the image is %d\n",height);  //display dimensions
   printf("The width of the image is %d\n",width);   //display dimensions
   system("PAUSE");

   CImgDisplay main_disp(image,"Image",0);      //display source image
   CImg<double> darkimage(image.dimx(),image.dimy(),1,3,0);
   for (int i=0;i<image.dimx();i++)
      for (int j=0;j<image.dimy();j++)
         for (int k=0;k<3;k++)
            {
            darkimage(i,j,0,k)=image(i,j,0,k)/2;
            printf("%f ",darkimage(i,j,0,k));
            }
         printf("\n");
   CImgDisplay dark_disp (darkimage,"Dark Image",0); //Display dark image

// Wait while the image is not closed

while (!main_disp.is_closed)
  main_disp.wait();

   return 0;
}
// EndOfMain
```

Subtracted Image and its Array




C:\Users\User\Desktop\lbyec72\build\myimage.exe

```
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```
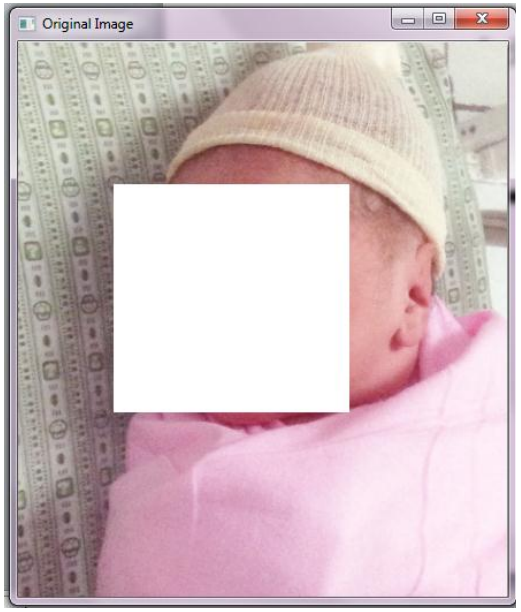

Note: CImg<T> is basically a 4th-dimensional array (width,height,depth,dim)

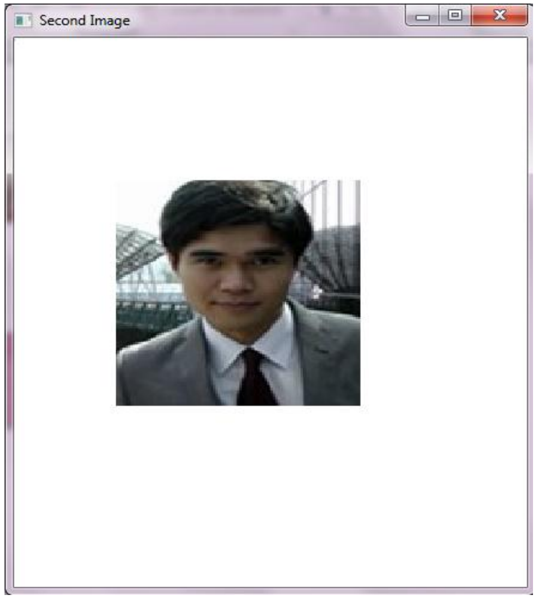
Subtracted Image Source Code

```
#include <stdio.h>
#include <stdlib.h>
#include "CImg.h"
using namespace cimg_library;
int main() {

CImg<double> subimage(image.dimx(),image.dimy(),1,3,0);
   for (int i=0;i<image.dimx();i++)
      for (int j=0;j<image.dimy();j++)
         for (int k=0;k<3;k++)
            {
            subimage(i,j,0,k)=image(i,j,0,k) - darkimage(i,j,0,k);
            printf("%f ",subimage(i,j,0,k)); // print the dark image matrix
            }
         printf("\n");
   CImgDisplay sub_disp(subimage,"Subtracted Image",0); //display dark image

 // Wait while the image is not closed
      while (!main_disp.is_closed)
      main_disp.wait();
   return 0;
}
// EndOfMain
```

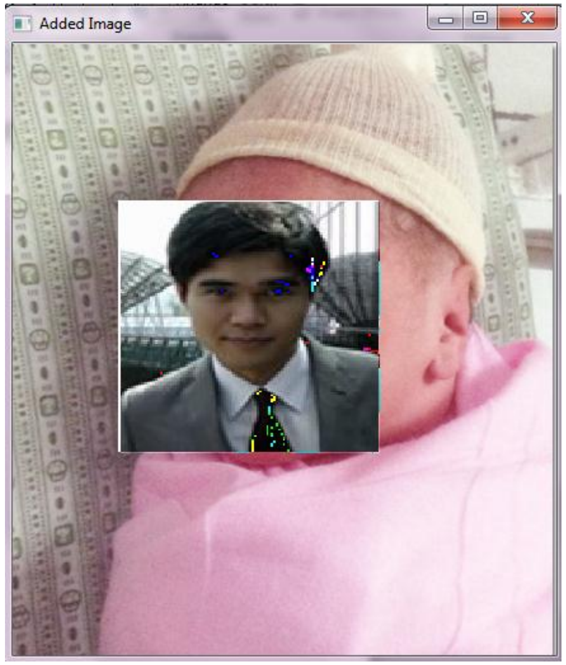
Image Addition



+



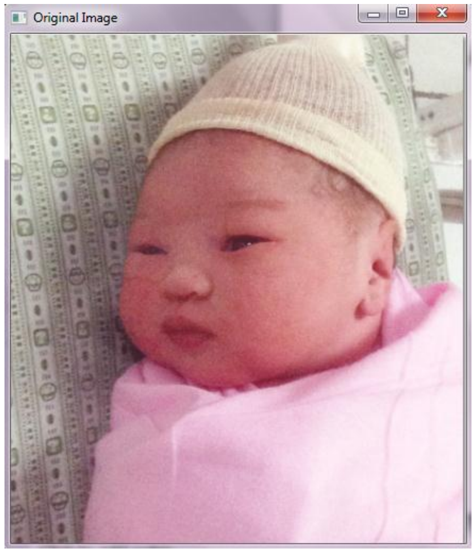
=



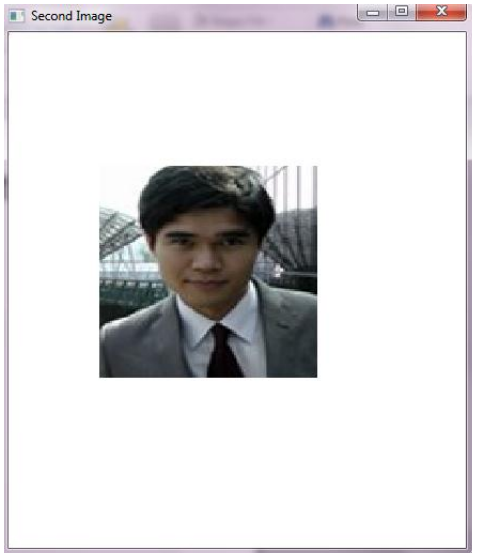
Addition Source Code

```
#include <stdio.h>
#include <stdlib.h>
#include "../CImg.h"
using namespace cimg_library;

int main() {
   CImg<double> image("img/baby3.bmp"),image2("img/melvin_kyoto.bmp");
   CImgDisplay main_disp(image,"Original Image",0); //display the original image
   CImgDisplay second_disp(image2,"Second Image",0); //display second image

   CImg<double> sumimage(image.dimx(),image.dimy(),1,3,0); //storage of result
   for (int i=0;i<image.dimx();i++)
      for (int j=0;j<image.dimy();j++)
         for (int k=0;k<3;k++)
            {
            sumimage(i,j,0,k)=image(i,j,0,k) + image2(i,j,0,k);
            printf("%f ",sumimage(i,j,0,k)); // print the sum image matrix
            }
         printf("\n");
   CImgDisplay sum_disp(sumimage,"Added Image",0); //display the result

   while (!main_disp.is_closed) // Wait while the image is not closed
   main_disp.wait();
   return 0;
}
```

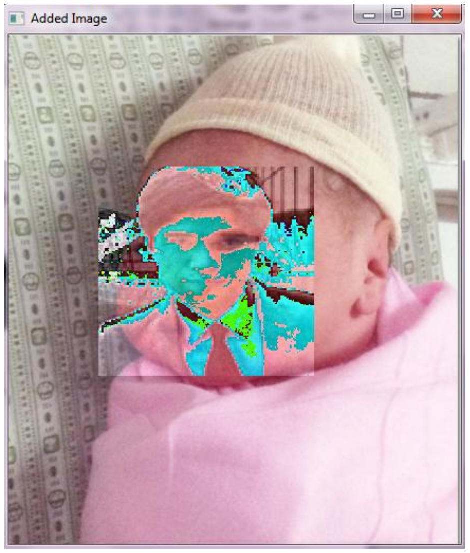
Addition Distortion



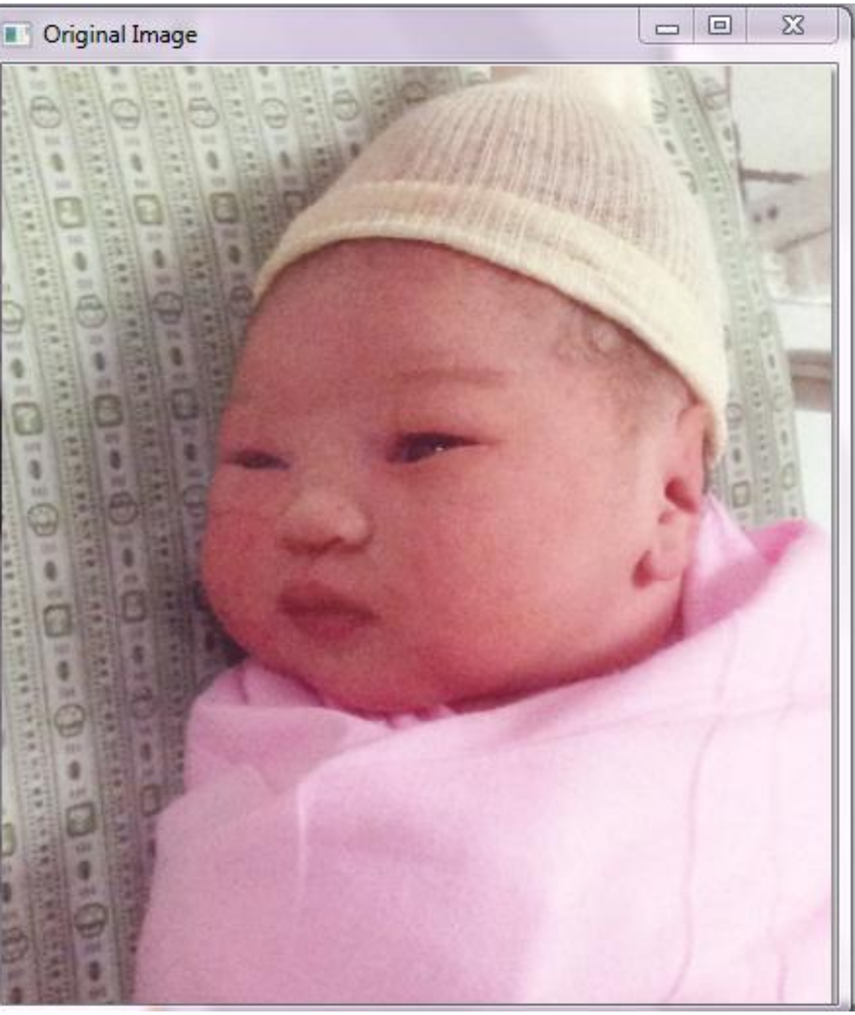
+



=



Subtraction



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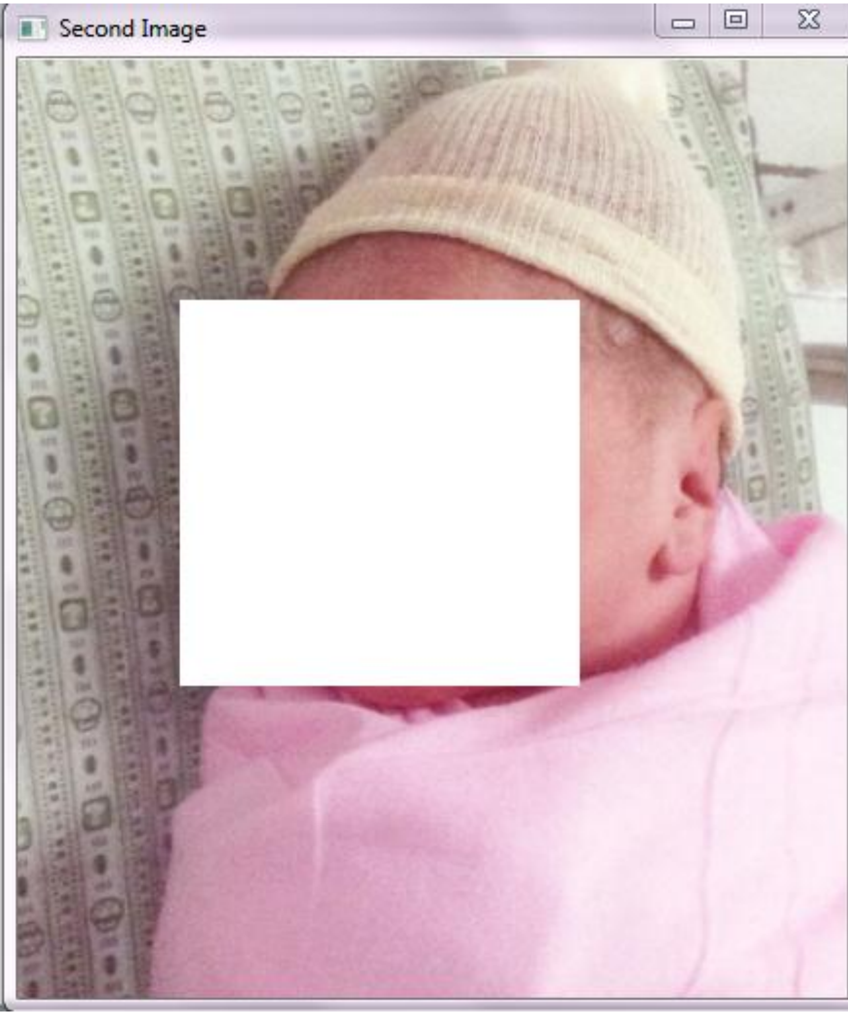
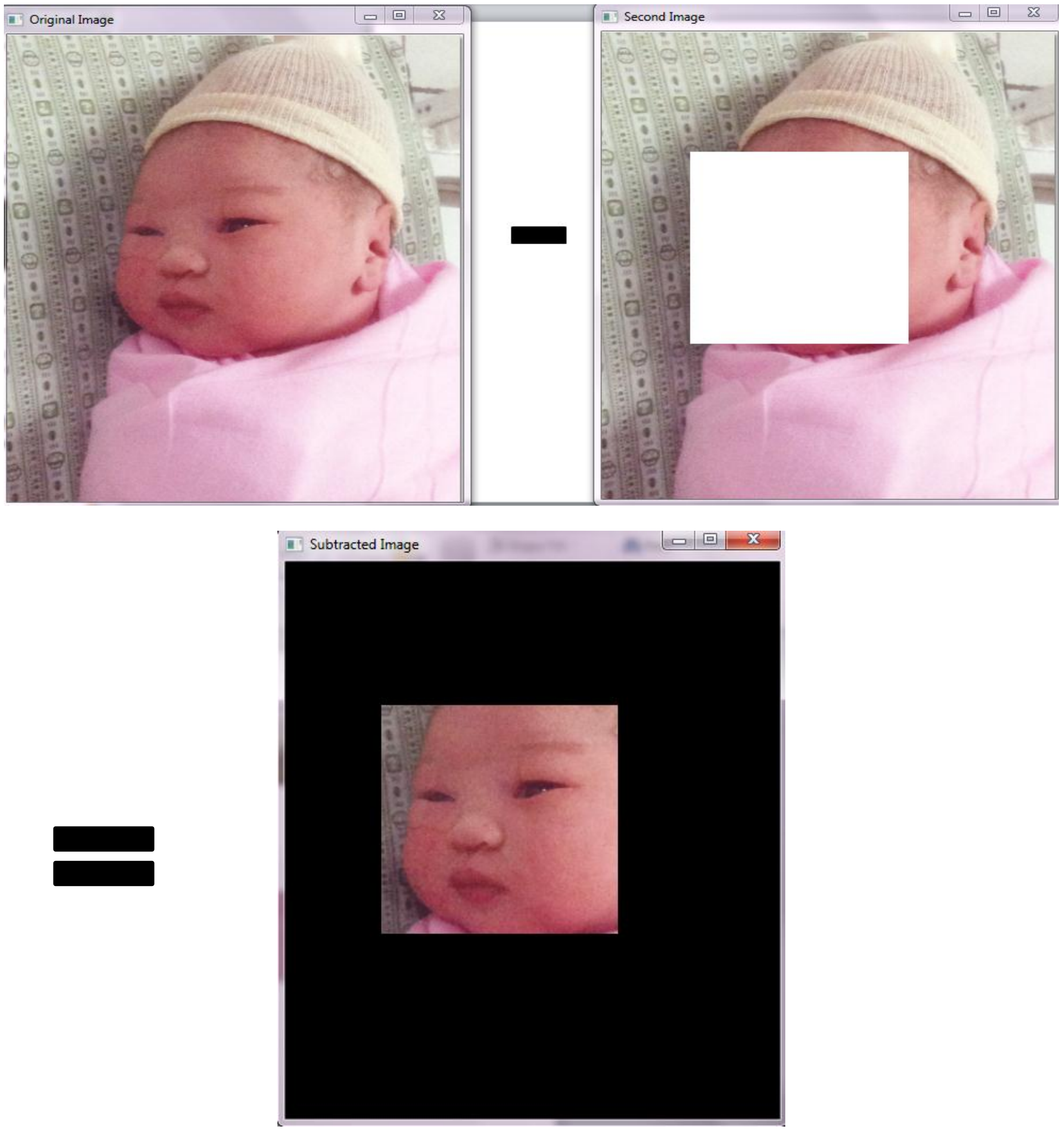


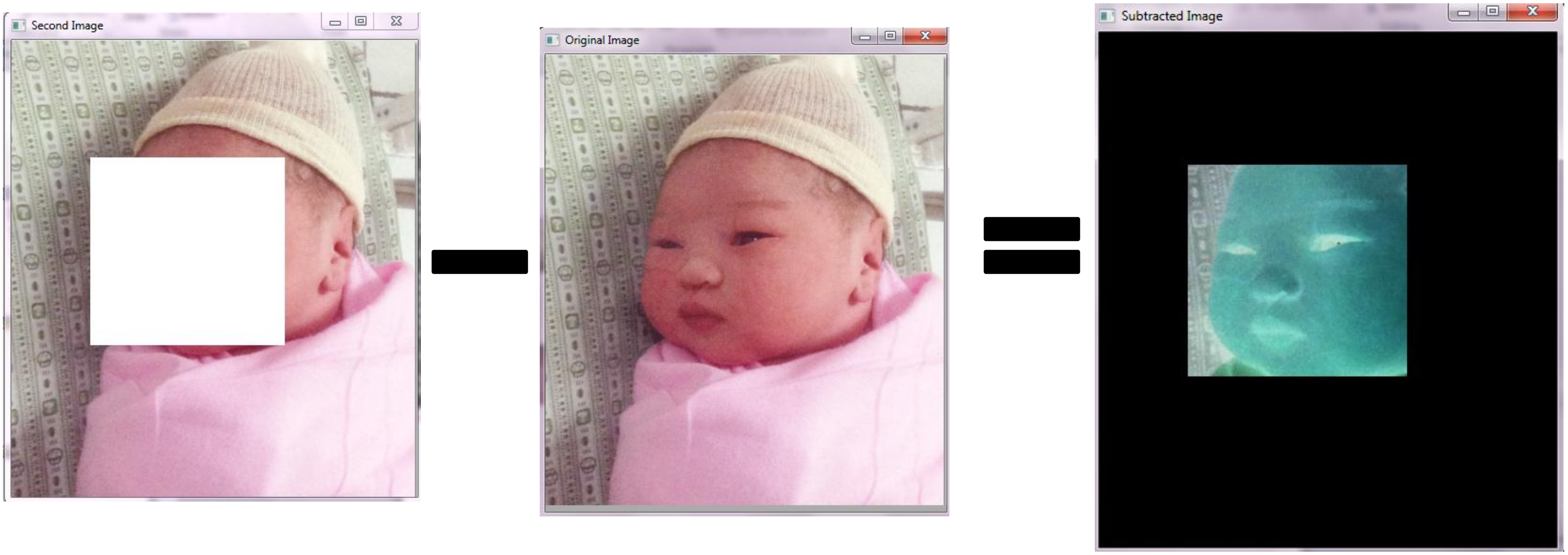
Subtraction



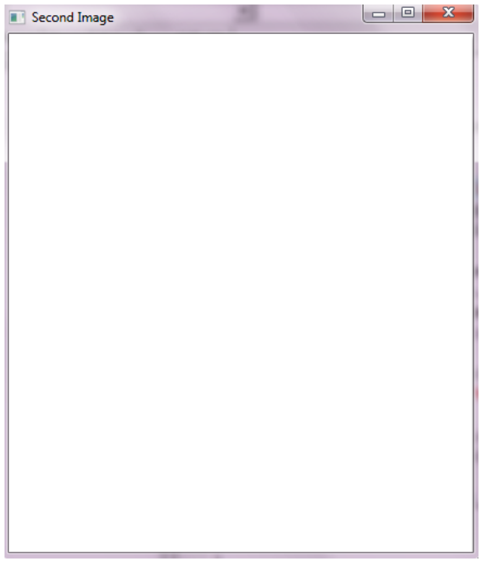
Source Code

```
#include <stdio.h>
#include <stdlib.h>
#include "CImg.h"
using namespace cimg_library;

int main() {
    CImg<double> image("baby2.bmp"),image2("baby3.bmp");
    CImgDisplay main_disp(image,"Original Image",0); //display the original image
    CImgDisplay second_disp(image2,"Second Image",0); //display second image

    CImg<double> subimage(image.dimx(),image.dimy(),1,3,0); //storage of result
    for (int i=0;i<image.dimx();i++)
        for (int j=0;j<image.dimy();j++)
            for (int k=0;k<3;k++)
                {
                subimage(i,j,0,k)=image(i,j,0,k) - image2(i,j,0,k);
                printf("%f ",subimage(i,j,0,k)); // print the difference image matrix
                }
            printf("\n");
    CImgDisplay sub_disp(subimage,"Subtracted Image",0); //display second image

    while (!main_disp.is_closed) // Wait while the image is not closed
    main_disp.wait();
    return 0;
}
```

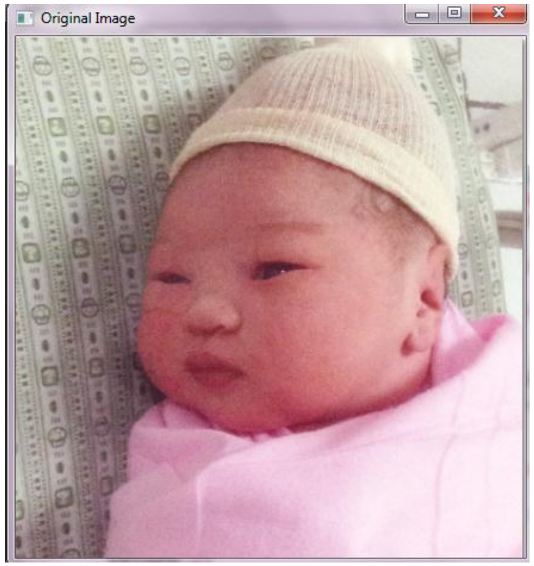
Negative



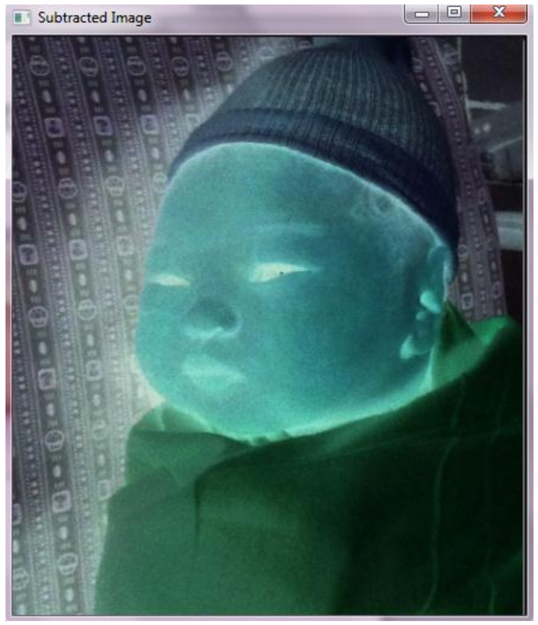
Negative



−



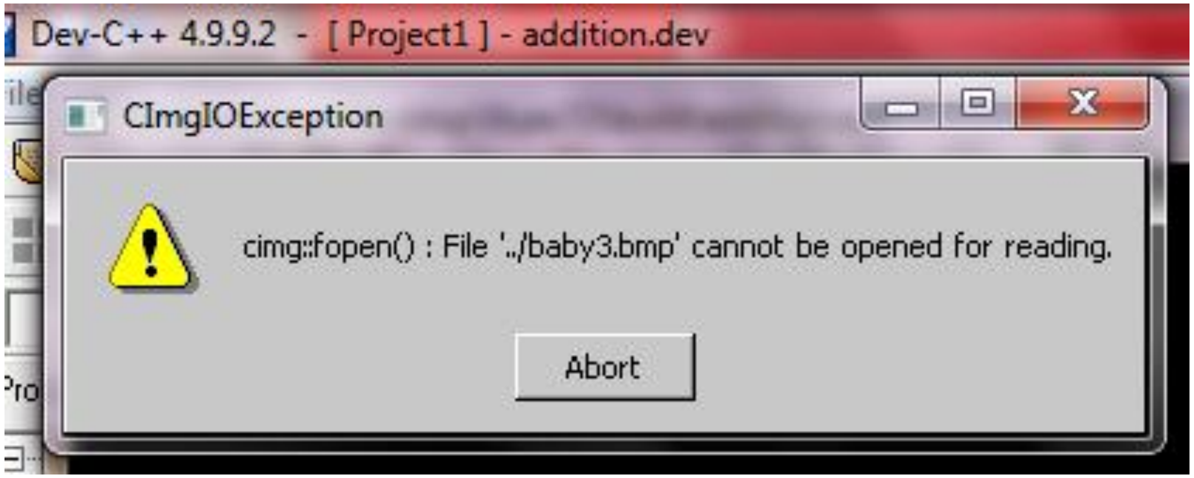
=



Addendum

Errors

- Devcpp cannot find the filename.bmp file.
- This error is caused by faulty directories.


Dev-C++ 4.9.9.2 - [Project1] - addition.dev

CImgIOException

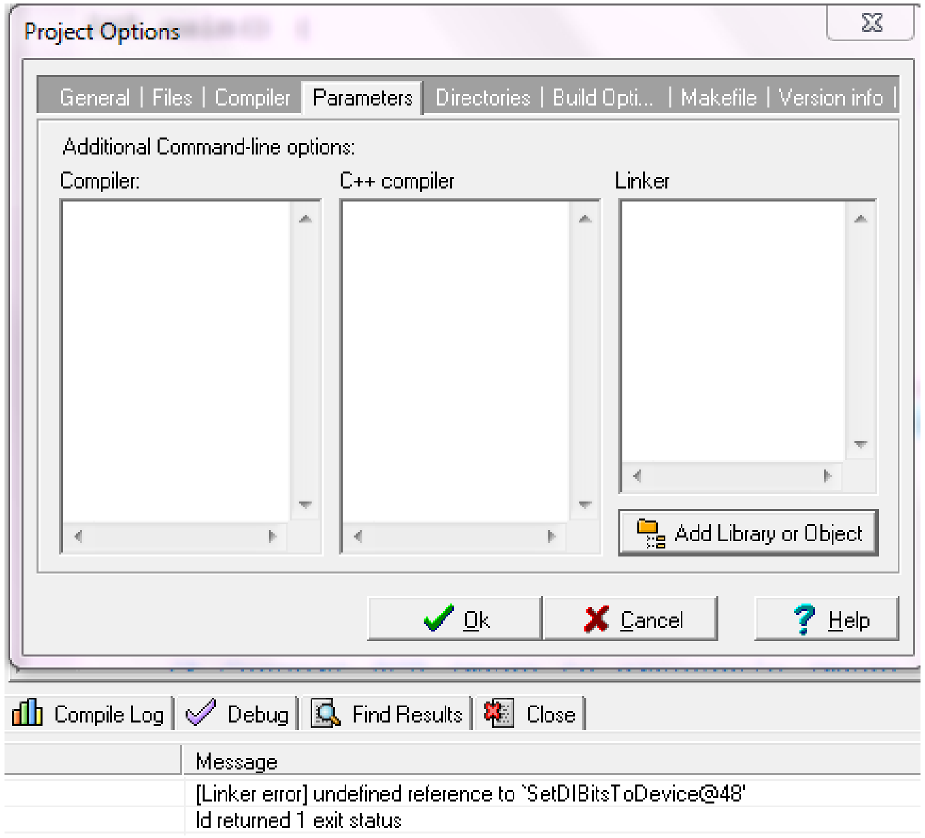
```
cimg::fopen() : File '../baby3.bmp' cannot be opened for reading.
```

Errors

- [*Build Error*] [main.o] *Error* 1
- This is a directory error experienced when you move the project .dev file in another directory from where it was created.

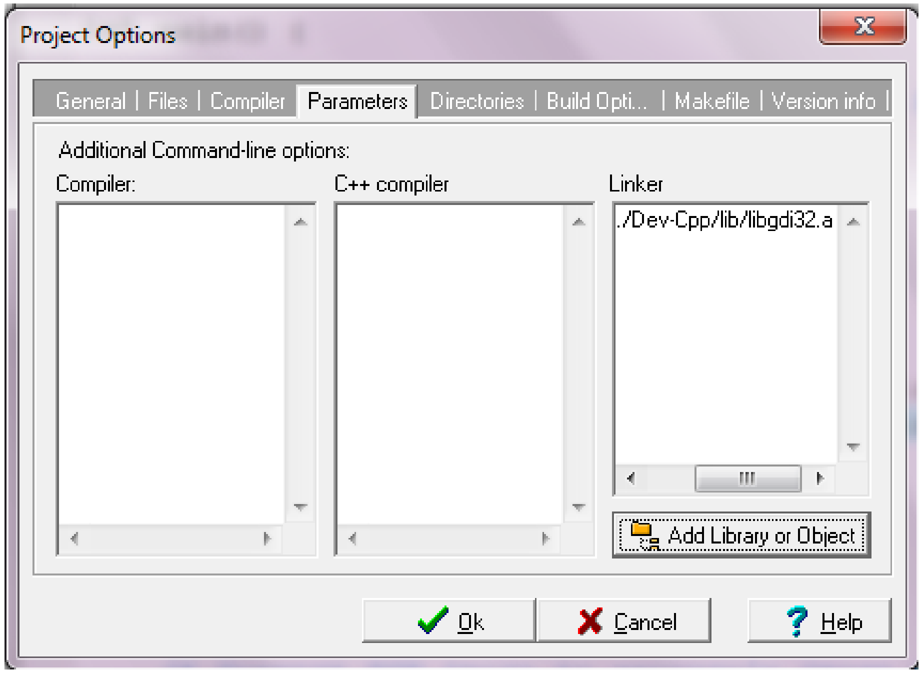
Errors

- Linker Error


Project Options
General | Files | Compiler | Parameters | Directories | Build Opti... | Makefile | Version info
Additional Command-line options:
Compiler:
C++ compiler
Linker
Add Library or Object
Ok
Cancel
Help
Compile Log
Debug
Find Results
Close

```
Message
[Linker error] undefined reference to `SetDIBitsToDevice@48'
ld returned 1 exit status
```

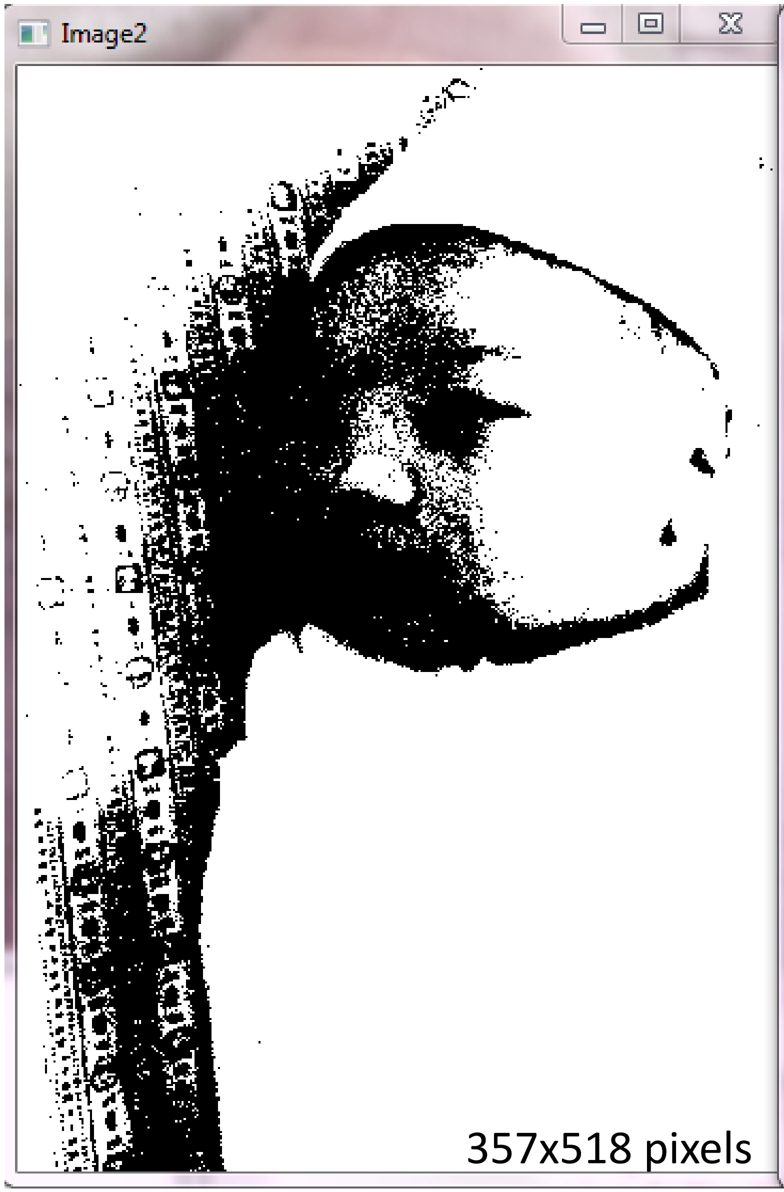
Solution:


Project Options
General | Files | Compiler | Parameters | Directories | Build Opti... | Makefile | Version info
Additional Command-line options:
Compiler:
C++ compiler
Linker
Add Library or Object
Ok
Cancel
Help

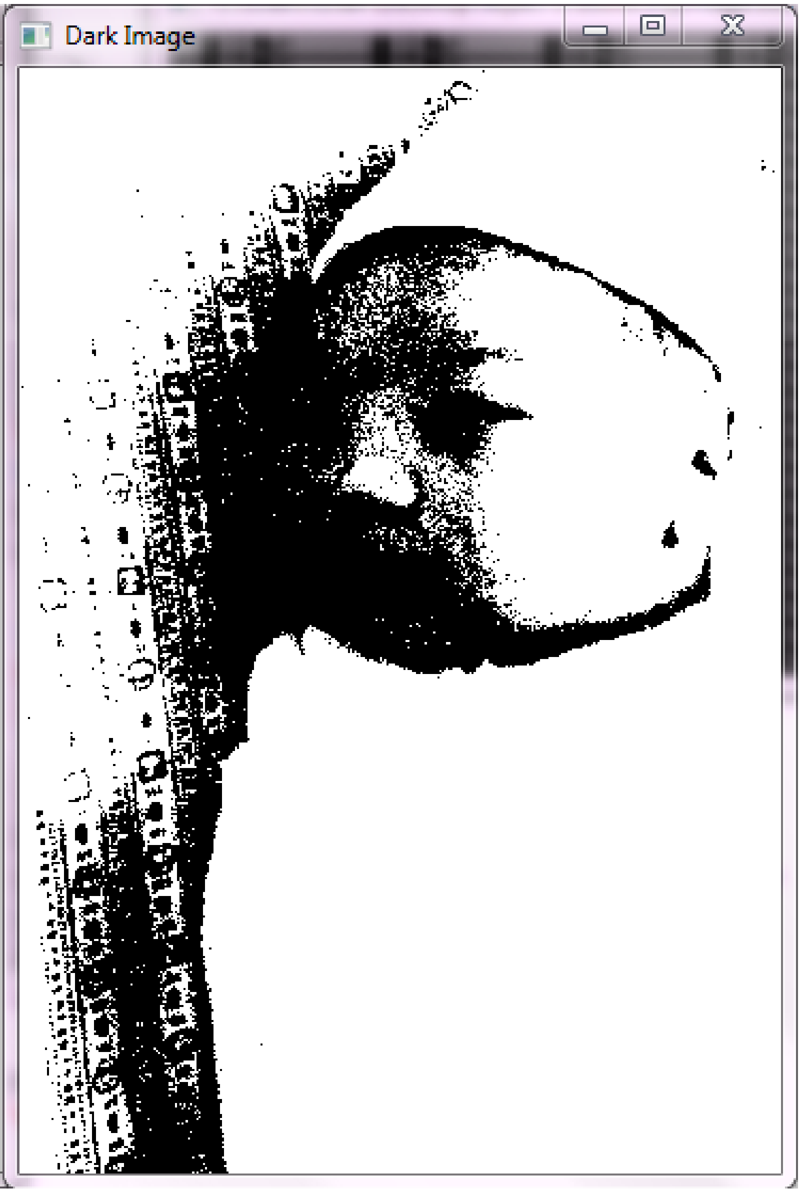
```
../Dev-Cpp/lib/libgdi32.a
```

Add Dev-Cpp/lib/libgdi32.a in parameters for the Linker In Project Options.

1 Bit Binary Bitmap Image (.bmp)



357x518 pixels



Source Code

```
#include <stdio.h>
#include "CImg.h"
using namespace cimg_library;

int main() {
CImg<double> image2("img/baby.bmp");
   CImgDisplay main_disp2(image2,"Image2",0);
   CImg<double> darkimage2(image2.dimx(),image2.dimy(),1,3,0);
   for (int i=0;i<image2.dimx();i++)
      for (int j=0;j<image2.dimy();j++)
         for (int k=0;k<3;k++)
            darkimage2(i,j,0,k)=image2(i,j,0,k);
   CImgDisplay dark_disp2(darkimage2,"Dark Image",0);
                                                                        //Display dark image

   while (!main_disp.is_closed) // Wait while the image is not closed
   main_disp.wait();
 return 0;
}
```

References

- The CImg 1.2.5 Library Reference Manual, Generated by Doxygen 1.5.3, 2007.
- Vicknesh Selvam, "An Introduction to the CImg Library“ A project conducted with the aid of Professor Todd Wittman.
- http://cimg.sourceforge.net/reference/