Q3 Report

The GUI part is implement using python `tkinter`

File input

- The function `read_bmp()` is for file input, which returns a "bmp file path".

```
bmp_path = filedialog.askopenfilename(initialdir=os.getcwd(),
                                      title="Please select a bmp file: ")
if bmp_path == '':
    exit()
```

  - I use the `filedialog` in tkinter library to ask user to choose an input file.
  - If user open the dialog box but did not choose any file, the program finish

File processing

The function `bmp_to_binary()` convert a bitmap file to binary file, and returns the binary in an array.

- Firstly, the function read the input file and divide it into three parts:
  - `bmp_header` contains the first 14 bytes in the file, which is the **bitmap file header**. It stores the general information of the file.
  - `dib_header` contains the 14th - 54th bytes in the file, which is the **DIB header**. It stores the detailed information about the file, such as the width and height of the image, number of bits per pixel, etc.
  - `data` contains the rest of the file, which is the **actual image data**.
- Then, calculate **the number of dummy bytes** in each row of the image
  - `dib_header[14]` stores the information of the **number of bits per pixel**
  - calculate the **row width**:
    - $RowWidth = 4 * \lceil \frac{biWidth * BitsPerPixel}{32} \rceil$
  - calculate the **number of dummy bytes per row**:
    - Since we are only using 24-bit bmp here, a pixel contains 3 bytes.
    - $NumDummyButes = RowWidth \% 3$
- Since the color stored in **big endian**

Bytes in data	Bytes in big endian	color channel bit mask
00 00 FF	FF0000	red
00 FF 00	00FF00	green
FF 00 00	0000FF	blue

  - since blue is the biggest number in original data, the color stored sequence should be blue -> green -> red.
- Put the data in a `pixel` array, which is a 2D array, each element is a small array contains an RGB color.

- Finally return the `pixel` array

GUI - display the image on screen

The function `draw_bmp` is to draw the bmp image on the GUI.

Canvas

```
img = PhotoImage(master=canvas, width=biwidth, height=biheight)
canvas.create_image((450, 250), image=img, state="normal")
for i in range(biheight):
    for j in range(biwidth):
        pixel_color = tuple(pixel[j + i * biwidth])
        pixel_color = rgb_to_hex(pixel_color)
        img.put(pixel_color, (j, i))
```

- canvas is a python GUI widget that allow programmer draw pixels on it.
- Here I use a tkinter widget `PhotoImage` to draw pixels.
- When user open this application, The GUI show the original bmp image.

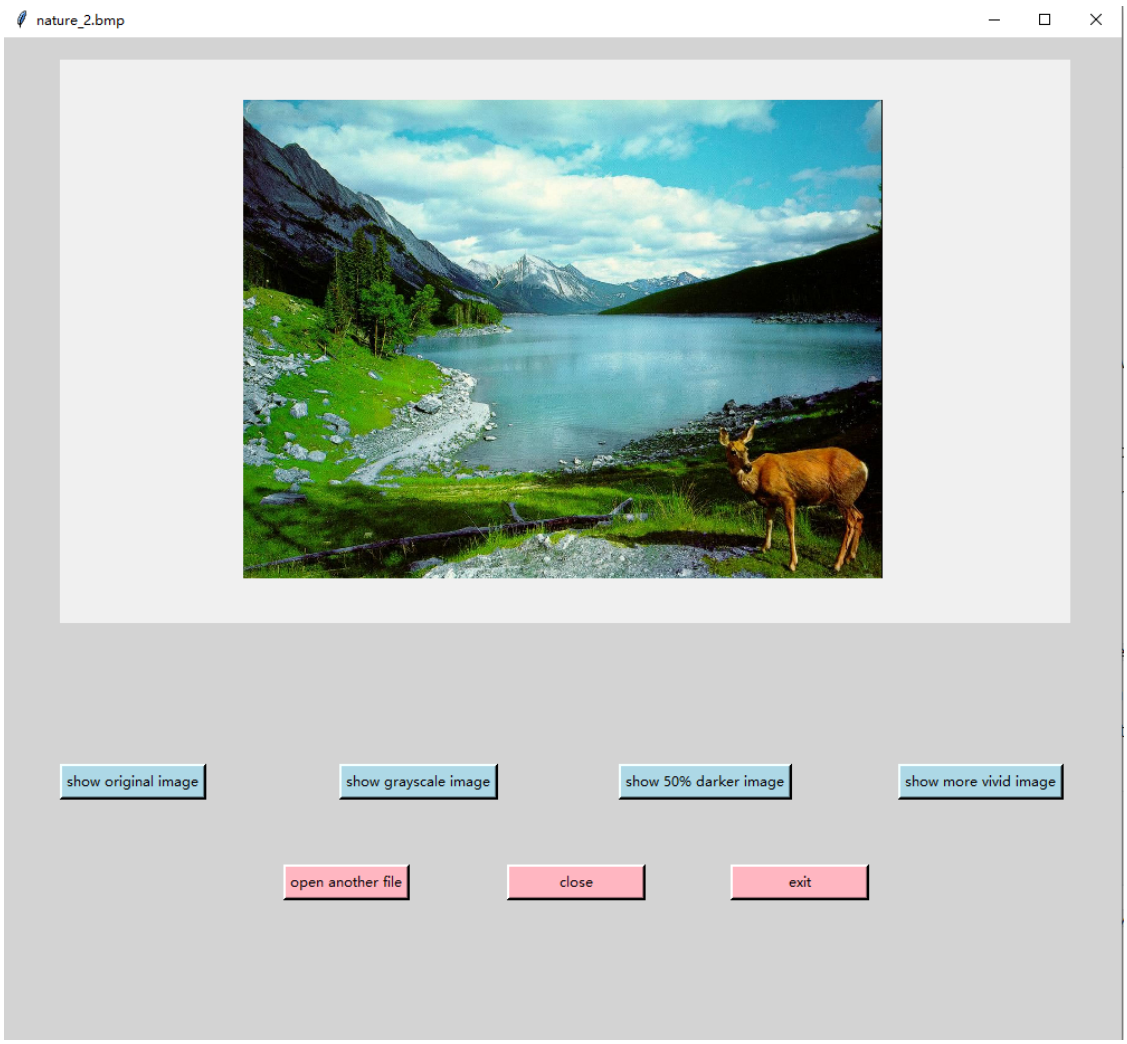
Frame

- I use a GUI widget `Frame` to create an area contains button allowing user to interact with this program.

show original image

The function `show_original_image()` allow user to change to original image view when press the `show original image` button

- In this step, I found that if the number of dummy bytes is 0 and `biwidth` is odd, the image will cut the last byte of each line to the next line. To avoid this, `biwidth` should plus 1



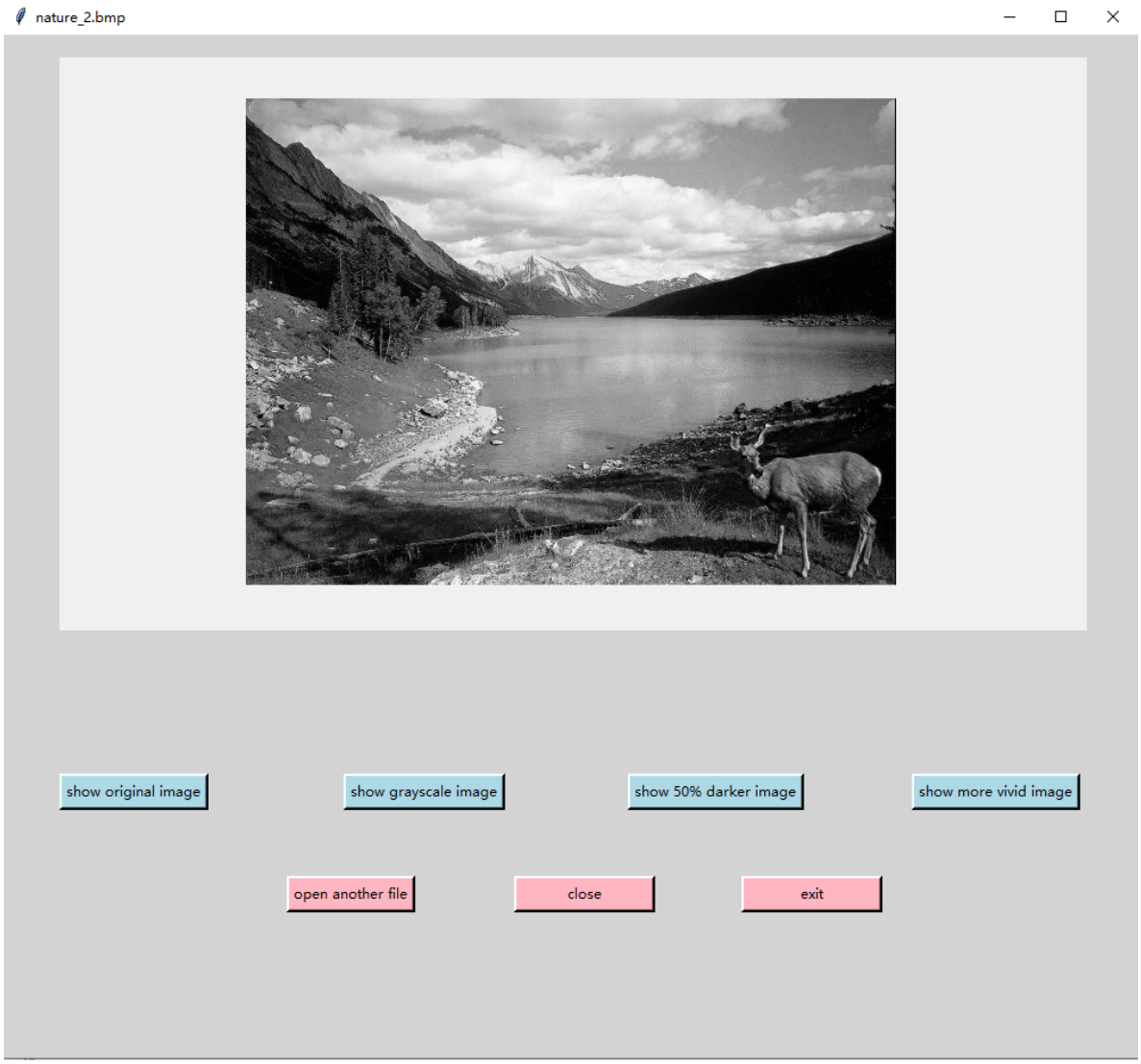
refresh by the grayscale image

The function `color_to_grayscale()` is to convert the `pixel` array to a `pixel_grayscale` array.

- First convert RGB color to YUV color using the function from programming assignment 1.
- Since `PhotoImage` can only show the RGB color, if I want to show only the Y channel (the grayscale) in YUV color model, I need to put all the channel equals to Y, the calculation is as this:

```
Y1 = round(0.299 * R + 0.587 * G + 0.114 * B)
U = Y1
V = Y1
```

- The canvas will show the grayscale image view when user press the button `show grayscale image`.



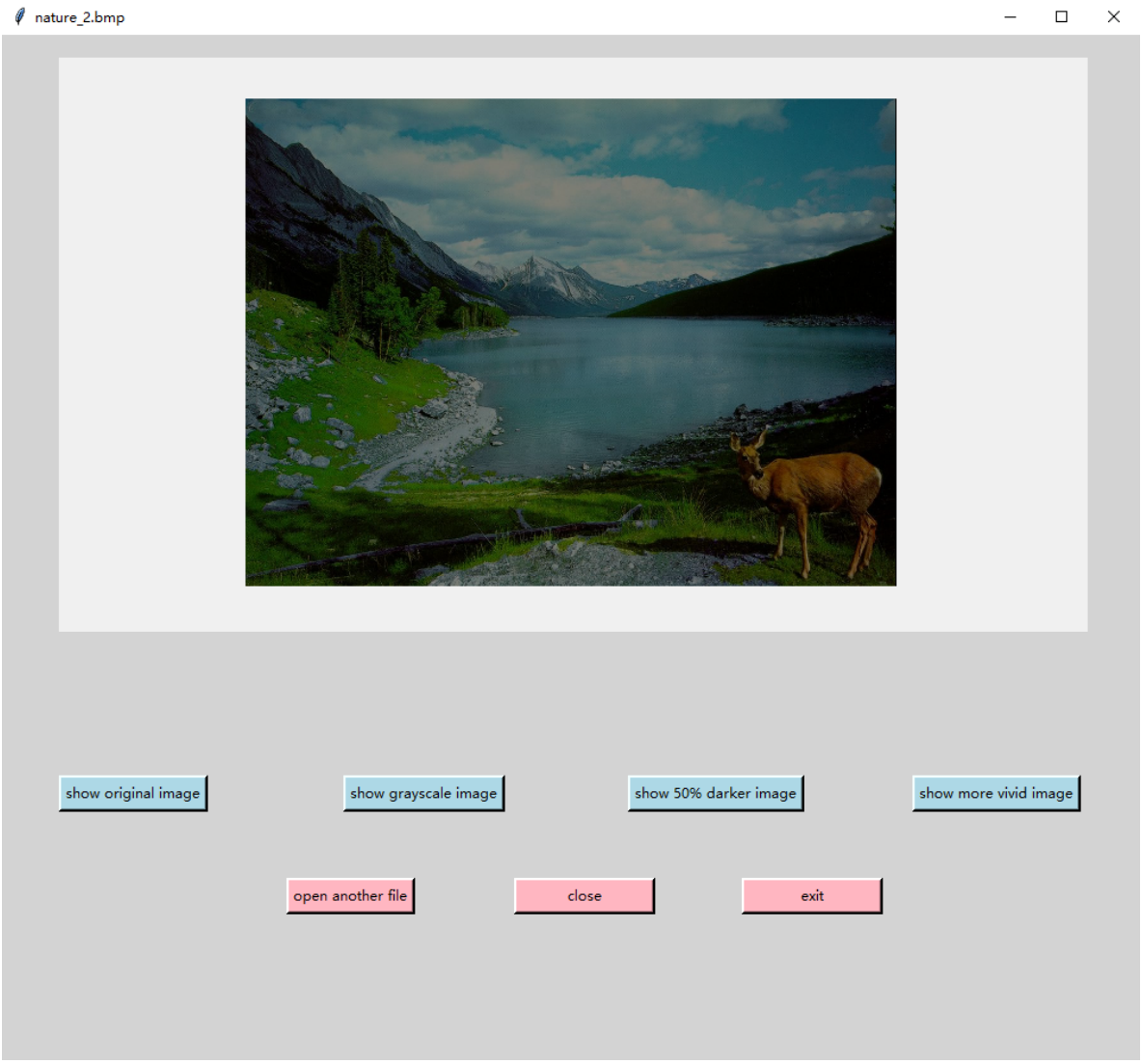
refresh by 50% darker image

The function `darken_bmp()` is to convert the `pixel` array to a `darker_pixel` array.

- The calculation method is to time 50% on each color channel for every pixel in `pixel` array.

```
darker_pixel[i][0] = int(0.5 * pixel[i][0])
darker_pixel[i][1] = int(0.5 * pixel[i][1])
darker_pixel[i][2] = int(0.5 * pixel[i][2])
```

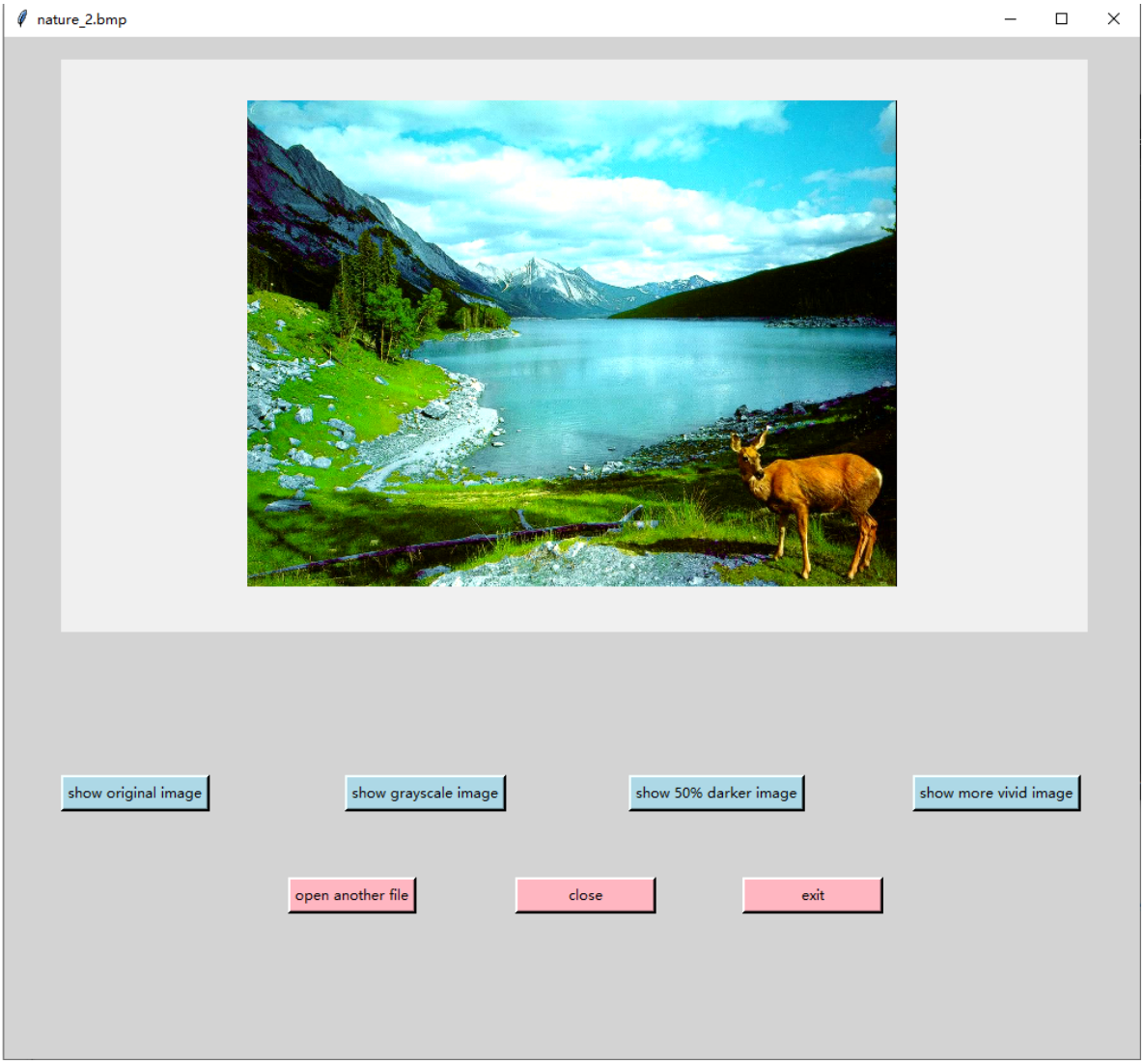
- The canvas will show the 50% darker image view when user press the button `show 50% darker image`.



refresh by more vivid image

The function `lighten_bmp()` and `higher_color_saturation()` is to make the original image more vivid.

- `lighten_bmp()` makes the image lighter
- `higher_color_saturation()` makes the image color difference higher, which looks more vivid. The method is:
  - Let the color channel which contain the largest value larger.
  - Let the color channel which contain the smallest value smaller.
- The canvas will show the more vivid image view when user press the button `show more vivid image`.



other buttons

- `open another file` button allows user to open another file and process it.
- `close` button allows user to close the GUI window, but be cautious, it won't terminate the program.
- `exit` button allows user to terminate the program.