EECS10 Discussion Week9

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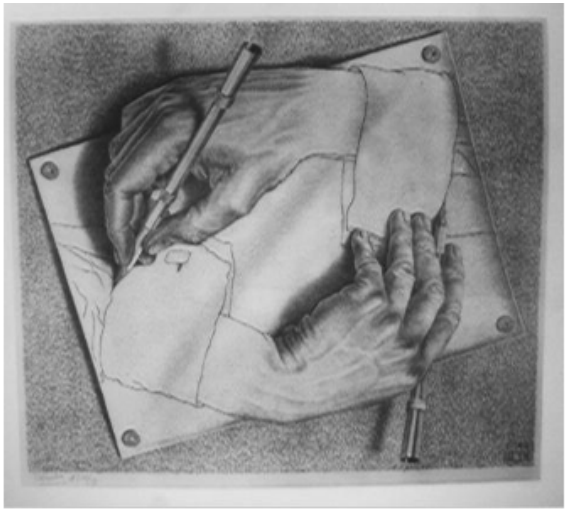
Recursion

- “A method of solving a problem where the solution depends on solution to smaller instances of the same problem.”
- Recursion step + base case
- Classical examples : Factorial and Fibonacci numbers
- Use gdb to track the control flow of the program

Russian dolls illustrate recursion [cambridgemaths.org]



M. C. Escher drawing

Character Arrays: Strings

- Text is represented by character arrays (aka strings)
  - Strings are null-terminated arrays of characters

- To input string, use scanf() format specifier: "**%Ns**"
  - where N specifies maximum field width = array size – 1
  - address argument can be **&string[0]**

- Let's write a program to reverse a string:

  - E.x. input: "smart", output: "trams"

Assignment 7

- A manual driven digital image processing program

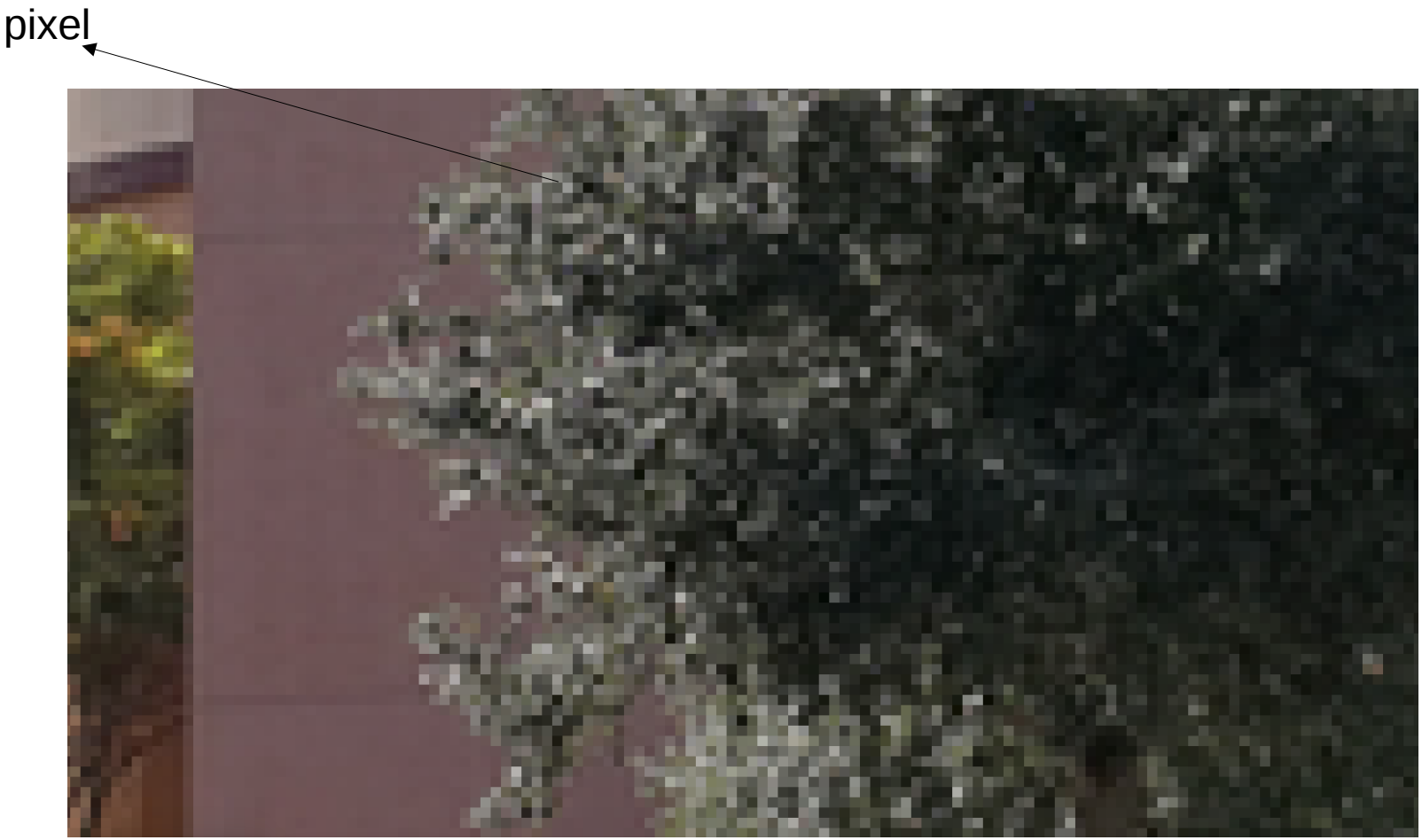
- Using function calls for image file handling, image processing, and testing.
  - Function declaration, function definition, function call
  - Function parameters
  - Scope of the variables

- Two-week assignment. Plan and start early!
  - Week1: Setup the working environment. Design the user menu. Try 1~2 operations on the image.
  - Week2: Complete the operations. Test your program.

- Use the web browser to view your image.

Pixels

- How to represent an image in digital computers:
  - An image is composed of picture elements aka pixels



RGB color components

- Three components (R, G, B) are used to represent one pixel:
  - R: intensity for red color
  - G: intensity for green color
  - B: intensity for blue color

- The range of intensity for each color component in the ‘library’ image is values between [0 to 255] (8-bit). Therefore, we use **char** type to store these values.

- Color examples:
  - **Red (255, 0, 0)**, **Green (0, 255, 0)**, **Blue (0, 0, 255)**
  - **Yellow (255, 255, 0)**, **Cyan (0, 255, 255)**, **Magenta (255, 0, 255)**
  - **(255, 255, 255)**, **Black (0, 0, 0)**

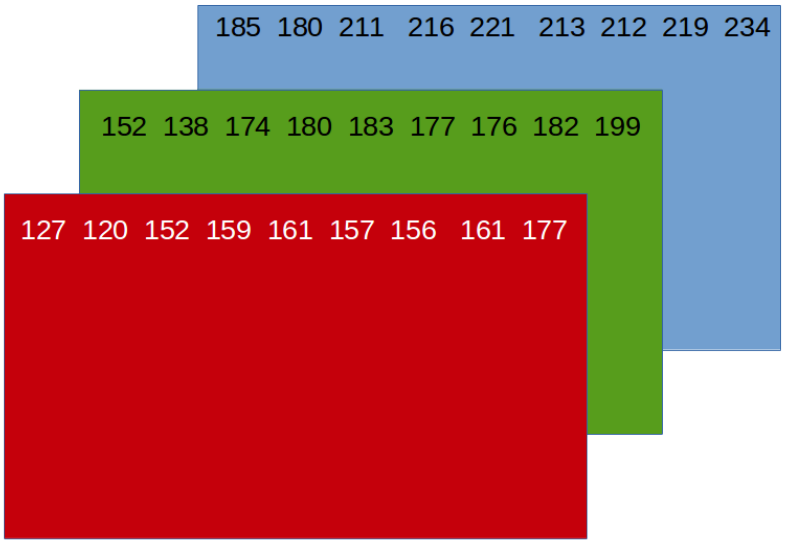
Image size

- Example image for Assignment 7 is UCI Science Library
- Size of image is (640 x 480) as (width x height)

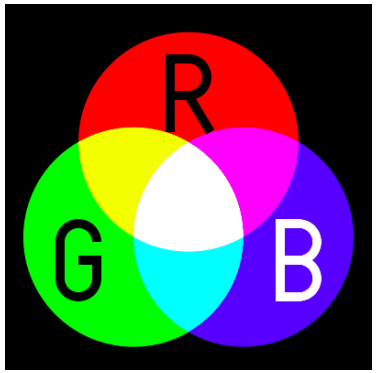
RGB colors

- A 2-dimensional array defines intensity of each color component

  unsigned char R[WIDTH][HEIGHT];
  unsigned char G[WIDTH][HEIGHT];
  unsigned char B[WIDTH][HEIGHT];



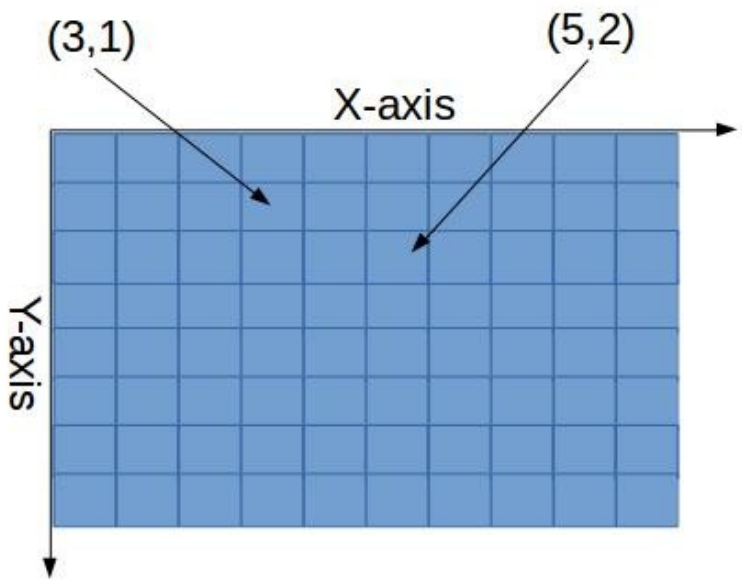
Colors intensities for red, green, blue colors taken from ‘library.ppm’ image by E. Arasteh



Additive color mixing [Wikipedia]

How to manipulate an image

- First, how to access every pixel in an image?
  - By coordinate of a pixel (x, y), x is coordinate on the X-axis and y is the coordinate on Y-axis
  - The color tuple of the pixel at coordinate (x, y) is :
    (R[x][y], B[x][y], G[x][y])



How to manipulate an image

- You can use nested for loops to manipulate pixels of an image:

```
for (int y = 0; y < HEIGHT; y++) {
   for (int x = 0; x < WIDTH; x++) {
      operate on pixel(x,y)
   }
}
```

Image processing functions

- Black and white
  - For each pixel at coordinate (x,y), compute the average of three color channels
  - Set the new value for all three color channels equal to the average
- Negative
  - Subtract R[x][y], G[x][y] and B[x][y] from the max intensity value (255) and update the pixel value
- Flip horizontally
  - Hint: scan only half of the image
- Mirror horizontally
  - Hint: scan only half of the image

Image processing functions

- Zoom-in
  - Typo: the correct coordinates of the zoom area are: (250, 100), (**569**, 100), (250, 339) and (**569**, 339)
  - Hint: arrows are pointing to coordinates in the new image

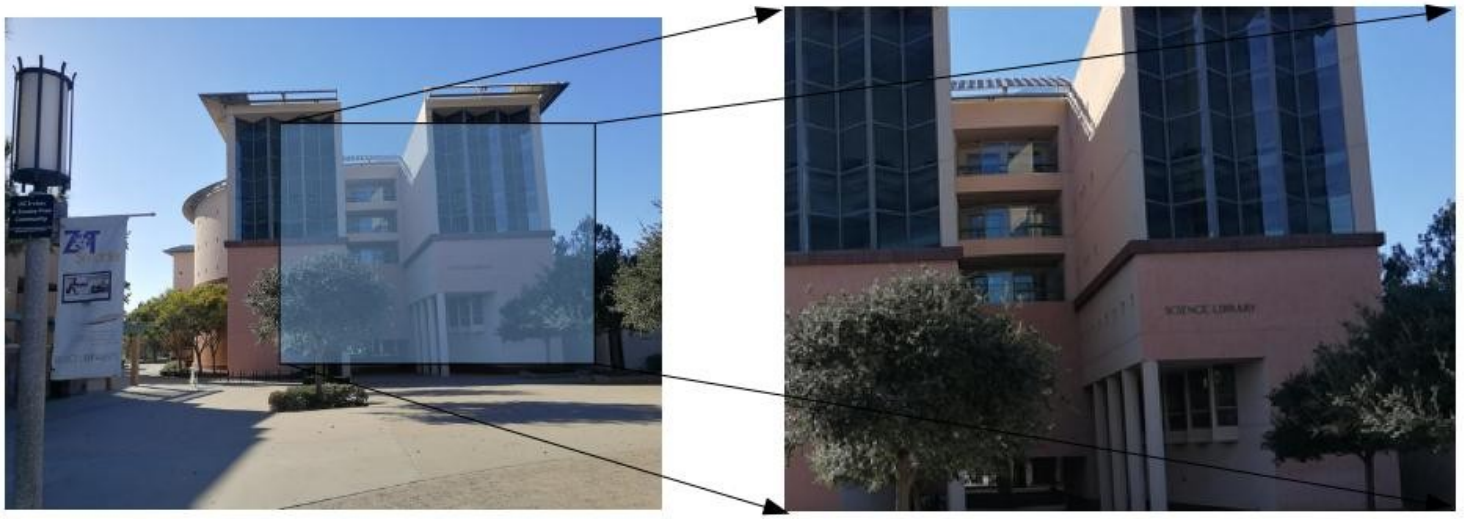


Image processing functions

- Add noise
  - – Randomly generate coordinates (2 random number for x and y)
  - – Set the intensity values to maximum (255, 255, 255) or minimum (0, 0, 0) alternatively for those noisy pixels

- Sharpen
  - – Slide the filter on the image and compute the weighted sum for each pixel
  - – Watch out for pixel values greater than max intensity (255) or less than min intensity (0)
  - – Watch out for pixel coordinates at the border of the image

Image processing functions (bonus)

- Overlay
  - – Pick either a pixel from the original image or a pixel from the overlay image depending on the background pixel intensity

- Add borders
  - – Turn the pixels on the border into a specific color (defined by the user)

AutoTest()

- Test your program
  - AutoTest() function
    - Call all functions together in the program.
    - Be careful with the arguments for each functions.
    - Sample function calls are listed in the assignment.
- Global constants
- Scope of the variables
- Pass by reference when using array parameters.
- Function prototypes mentioned in the assignment are very helpful hints.