EECS10 Discussion Week10

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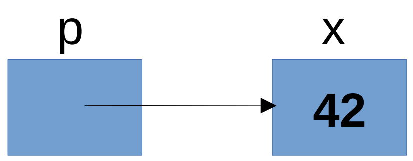
Pointers



- Pointers are variables whose values are addresses
  - The "address-of"operator (**&**) returns a pointer.

- Pointer Definition
  - The unary ***** operator indicates a pointer type in a definition

- Pointer initialization or assignment
  - A pointer may be set to the "address-of" another variable
  - A pointer may be set to 0 (points to no object)
  - A pointer may be set to NULL (points to "NULL" object)

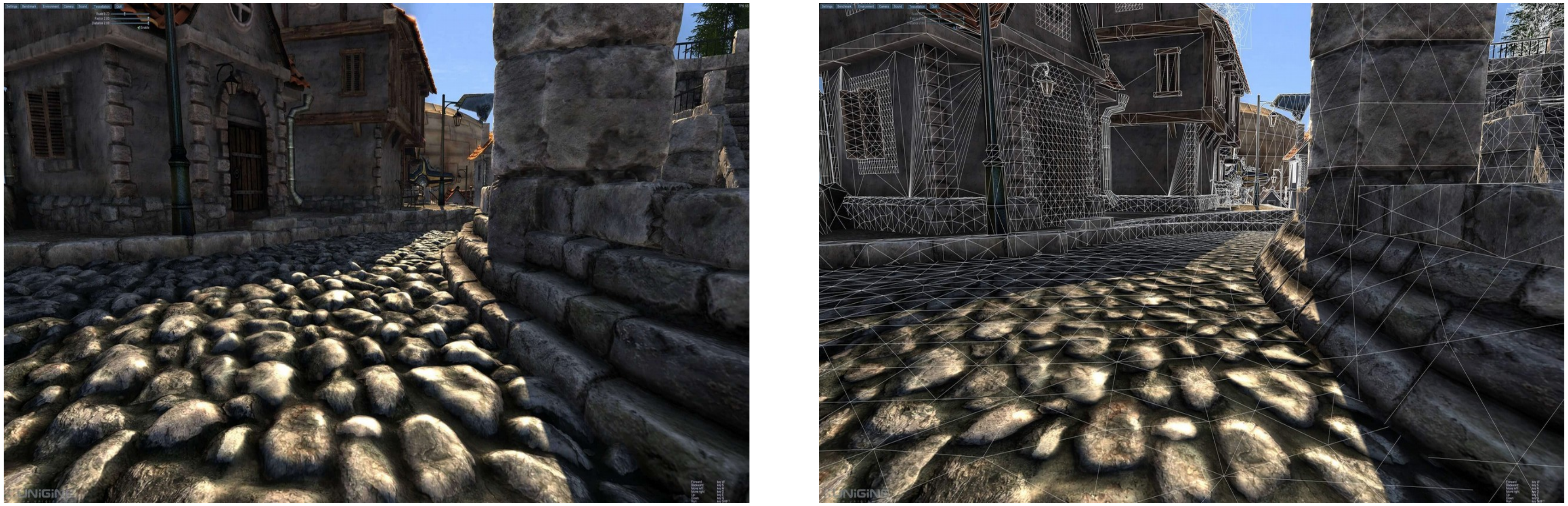
- Pointer Dereferencing
  - The unary * operator dereferences a pointer to the value it points to ("content-of" operator)
  - The -> operator dereferences a pointer to a structure to the content of a structure member

- Pointer arithmetic

3D game rendering

- Modern games can use millions of triangles to create their worlds, and every single one of those vertices will have been transformed and lit in some way.

- Let’s code two structs to hold a point and rectangle and display the coordinates of a rectangle using a pointer!



https://www.techspot.com/article/1857-how-to-3d-rendering-vertex-processing/

Files

- Up to now, all data processed is available only during program run time

- Persistent data is stored even after a program exits

- Persistent data is stored in files...
  - ... on the hard disk
  - ... on a removable disk (CD, memory stick, …)
  - … on network drive
  - … on a tape...

- Input and output from/to files is organized as I/O streams (a *stream* is a source or sink of data usually individual bytes or characters)

Standard I/O Functions

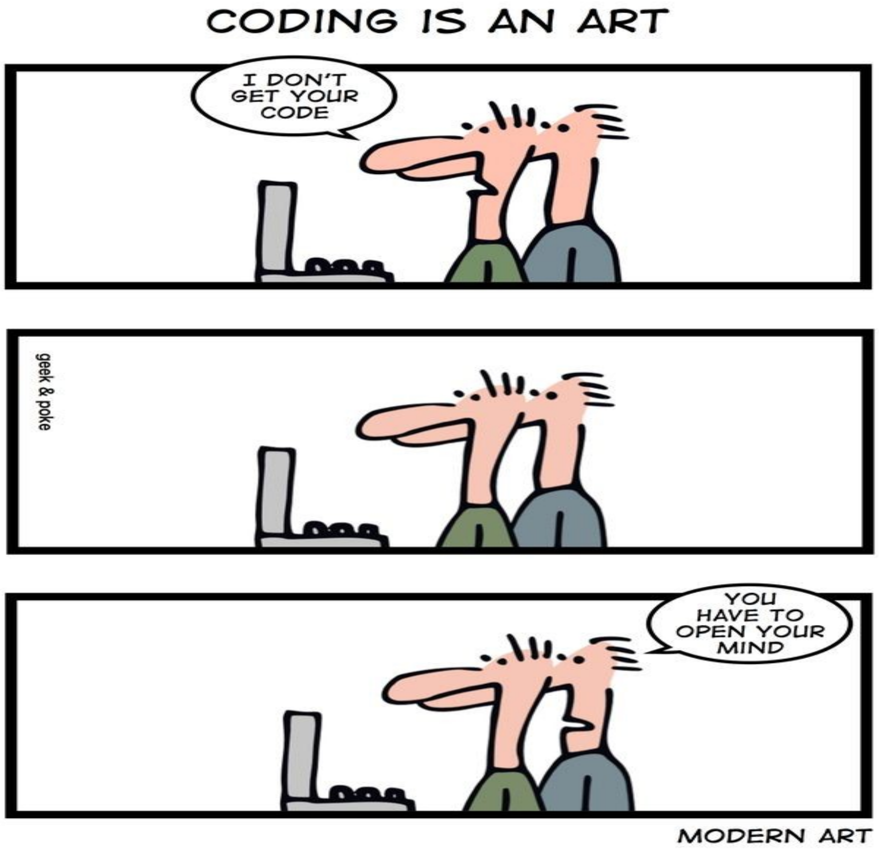
- I/O streams:
  - Standard I/O streams (opened by the system)
    - `stdin  i.e. scanf()`
    - `stdout i.e. printf()`
    - `stderr i.e. perror()`

  - File I/O streams (explicitly opened by a program)
    - Open a file `fopen()`
    - Write data to a file `fprintf()`
    - Read data from a file `fscanf()`
    - Close a file `fclose()`

- In C, all I/O functions are
  - ... declared in header file stdio.h
  - ... implemented in the C standard library

- Let’s write some code to draw a tree in a file!

Thank you!



Geek & poke, used under CC-BY-3.0

Backup slides: Assignment 7

- A menu 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

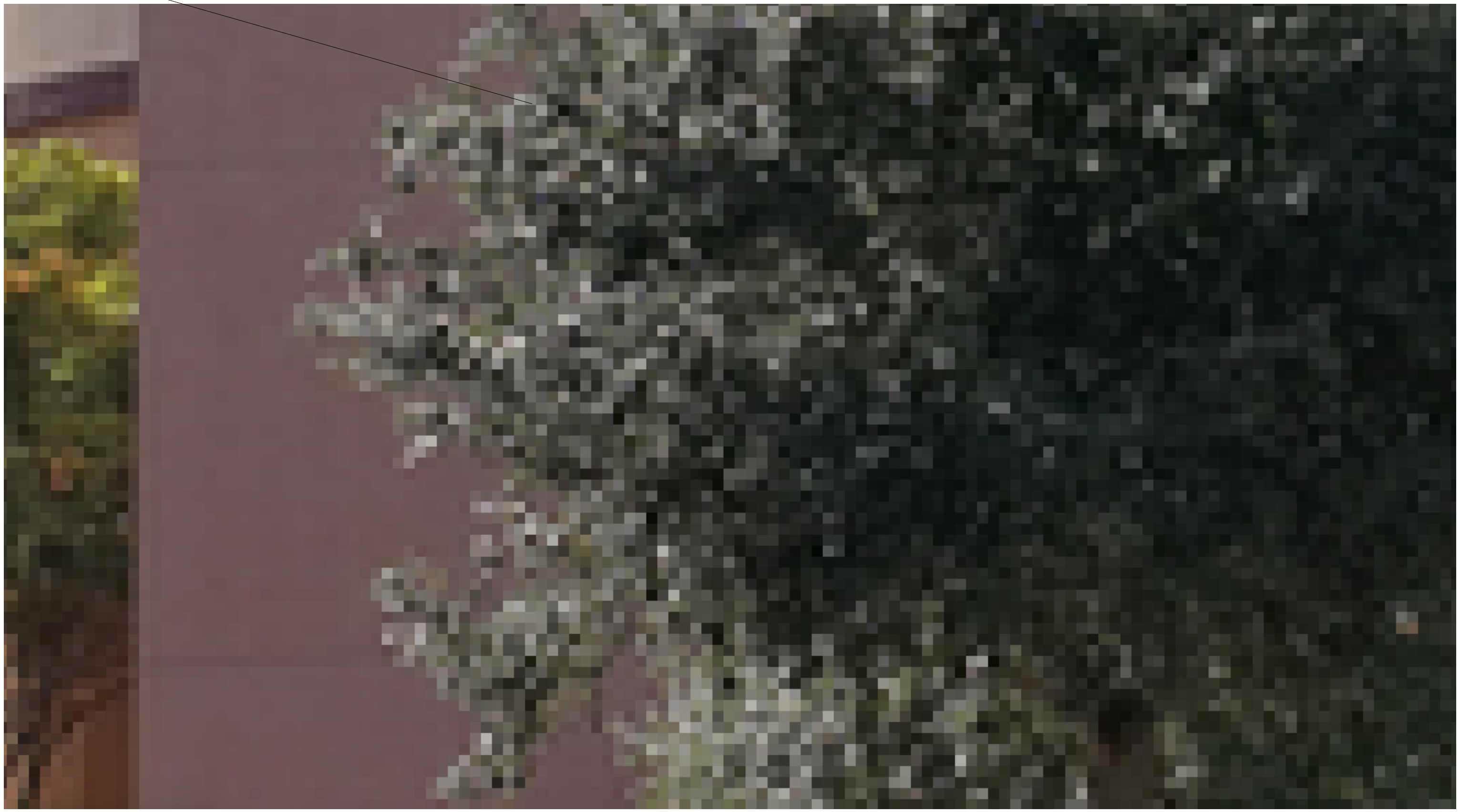
- Two-week assignment: **Start early, finish early!**
    - Week1: Setup the working environment, design the user menu, try 1~2 operations on the image.
    - Week2: Complete the operations, test your program.

- 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

pixel



RGB color components

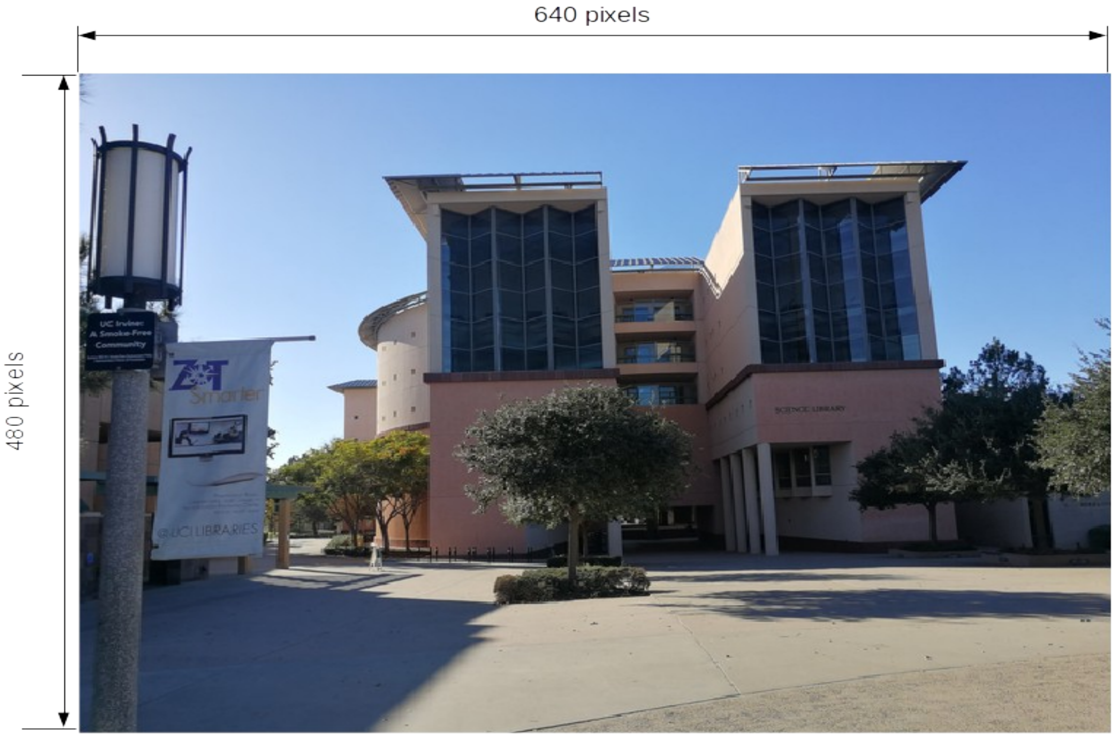
- Three components (R, G, B) are used to represent one pixel:
  - R: intensity for red color
  - G: intensity for green color
  - B: intensity for blue color

- 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

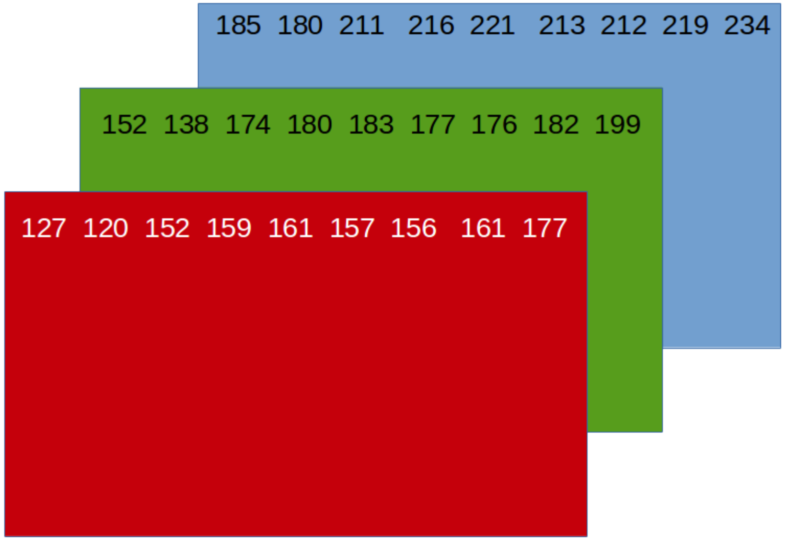
- Size of image is (640 x 480) as (width x height)



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];
```

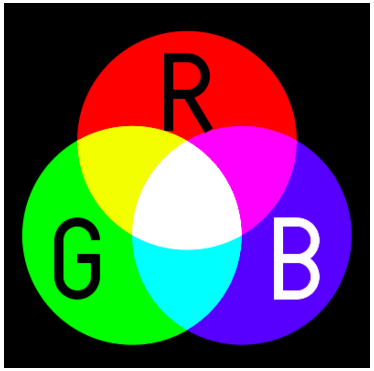


185 180 211 216 221 213 212 219 234

152 138 174 180 183 177 176 182 199

127 120 152 159 161 157 156 161 177

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

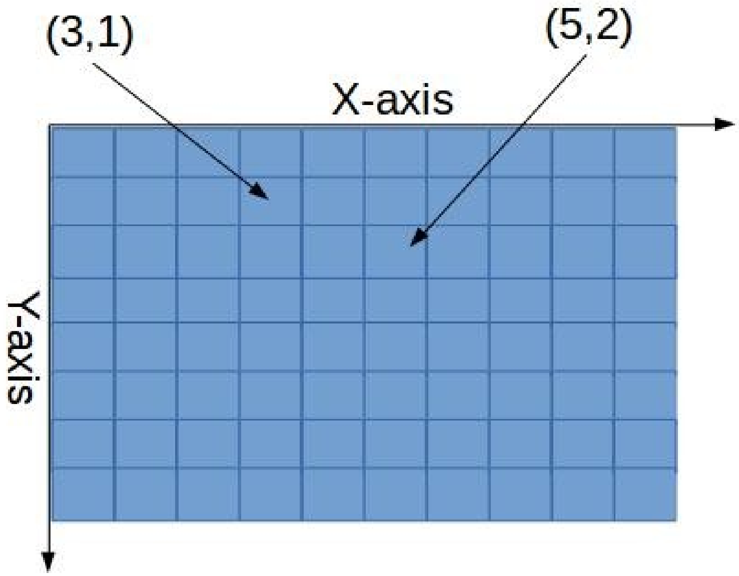


Additive color mixing [Wikipedia]

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
  - Hint: arrows are pointing to coordinates in the new image

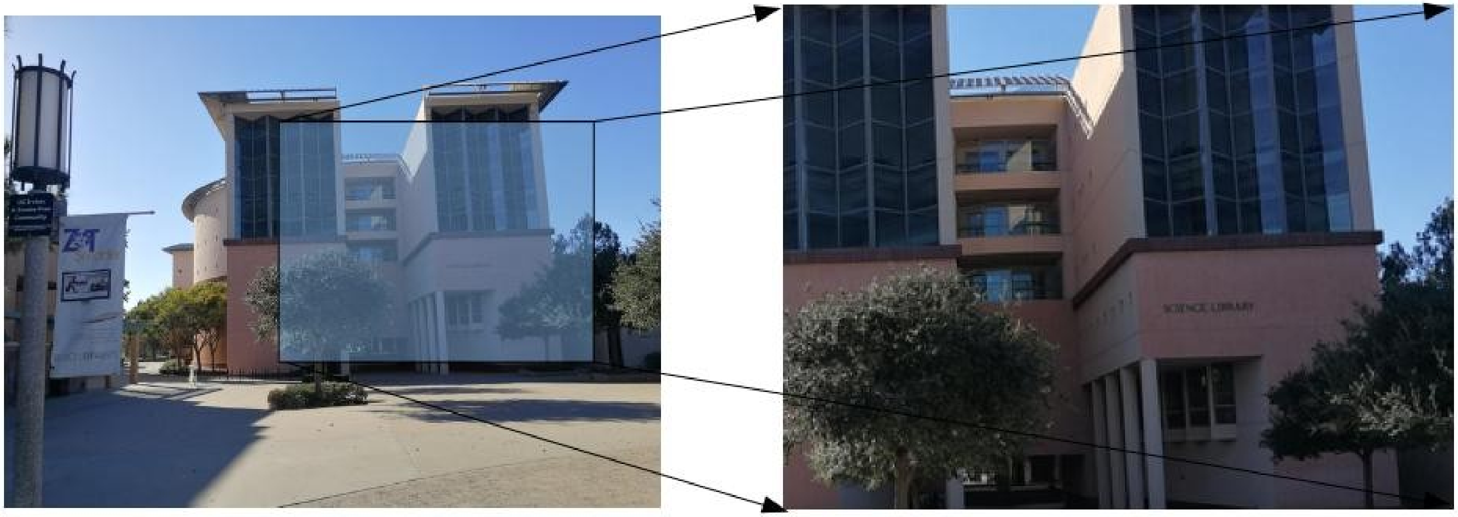


Image processing functions

- 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

- Exchange RG
  - Swap intensity of red and green channels

- 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

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