Course: CS 825
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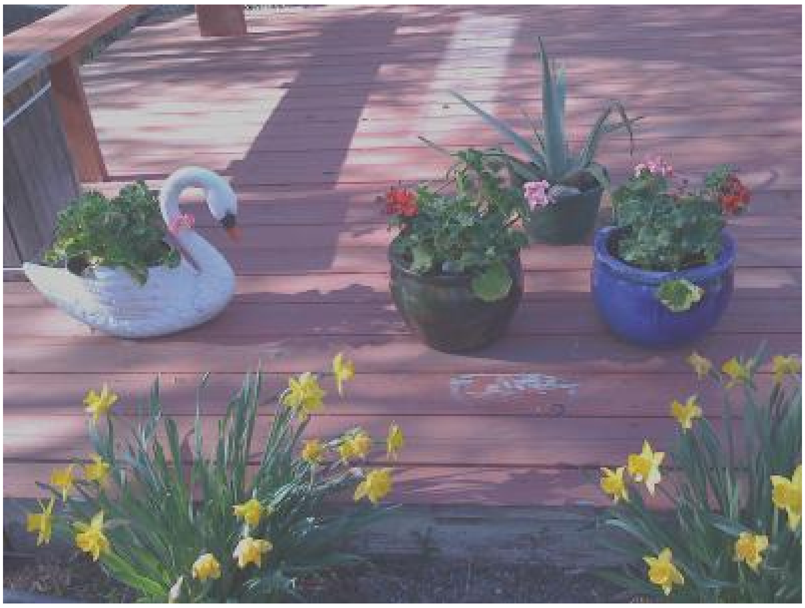
Programming language: JAVA

Programming 1

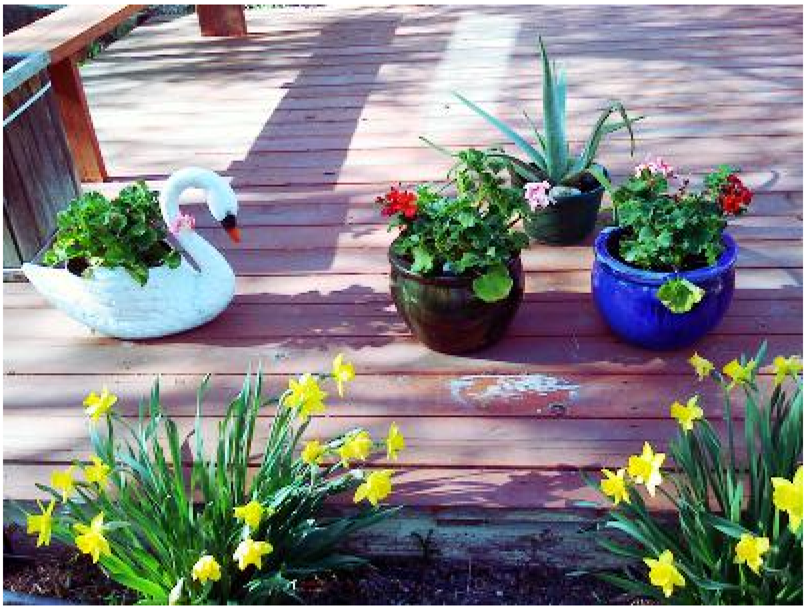
```
package Programming;

import java.io.*;

public class P1 {

	public static void main(String args[]) throws IOException {
		FileInputStream in = null;
		FileOutputStream out = null;
		try {
			in = new
FileInputStream("C:/Users/CHAO/Desktop/summer_deck2.raw");
			out = new
FileOutputStream("C:/Users/CHAO/Desktop/summer_deck2+.raw");
			int i, j, k;
			int[][][] image_in = new int[3][400][300];

			for (k = 0; k < 3; k++)
				for (i = 0; i < 400; i++)
					for (j = 0; j < 300; j++)
						image_in[k][i][j] = in.read(); // Read the input image into
											// image_in[][][]

			int[][][] image_out = new int[3][400][300]; // 3 is three channels for red,
green and blue
			int[] h = new int[256];
			int[] H = new int[256];

			for (k = 0; k < 3; k++) {

				for (i = 0; i < 256; i++) // initialization of h[]
					h[i] = 0;

				for (i = 0; i < 400; i++)
					for (j = 0; j < 300; j++)
						h[image_in[k][i][j]]++; // Compute the histogram of the
input
```

```
                                                // image and store it in h[]

                H[0] = h[0];
                for (i = 1; i < 256; i++) // Compute the cumulative histogram and
                                            // store it in H[]
                    H[i] = H[i - 1] + h[i];

                double s = 0.002125; // get the scaling factor S
                // 0.00213 is k-1/m*n which is 255(8 bits grayscale per
channel)/400*300

                for (i = 0; i < 256; i++) // Normalize H[] with the scaling factor S
                    H[i] *= s;

                for (i = 0; i < 400; i++)
                    for (j = 0; j < 300; j++) // get the image_out[] from the H[]
                        image_out[k][i][j] = H[image_in[k][i][j]];
            }

            for (k = 0; k < 3; k++)
                for (i = 0; i < 400; i++)
                    for (j = 0; j < 300; j++)
                        out.write(image_out[k][i][j]); // Write the result image
                                                        // image_out[][]

        } finally {
            if (in != null) {
                in.close();
            }
            if (out != null) {
                out.close();
            }
        }

    }
}
```

The original image:



The modified color image after applying the histogram equalization algorithm to R, G, and B channels separately



Programming 2

```
package Programming;

import java.io.*;

public class P2 {

    public static void main(String args[]) throws IOException {
        FileInputStream in = null;
        FileOutputStream out = null;
        try {
            in = new
FileInputStream("C:/Users/CHAO/Desktop/summer_deck2.raw");
            out = new
FileOutputStream("C:/Users/CHAO/Desktop/summer_deck2++.raw");
            int i, j, k;
            int[][][] image_in = new int[3][400][300];

            for (k = 0; k < 3; k++)
                for (i = 0; i < 400; i++)
                    for (j = 0; j < 300; j++)
                        image_in[k][i][j] = in.read(); // Read the
input image into
                                                        // image_in[][][]

            int[][][] image_out = new int[3][400][300]; // 3 is three
channels for red, green and blue
            double[][][] hsv = new double[3][400][300];

            // RGB to HSV
            int r, g, b;

            double rr, gg, bb;
            double h = 0, s, v;
            double min, max, delta;

            for (i = 0; i < 400; i++)
                for (j = 0; j < 300; j++)

                {
                    // do the calculation according to the
mathematical formula
```

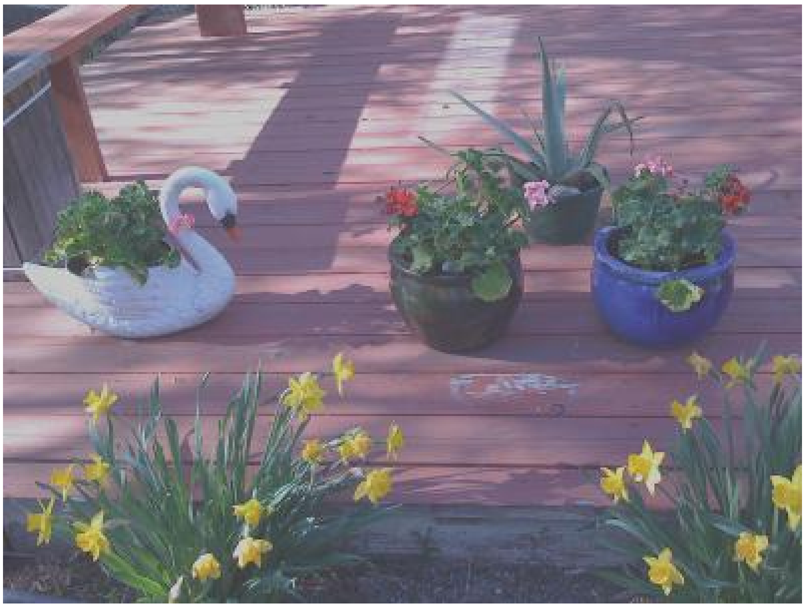
```
                r = image_in[0][i][j];
                g = image_in[1][i][j];
                b = image_in[2][i][j];

                rr = r / 255.0;
                gg = g / 255.0;
                bb = b / 255.0;

                min = Math.min(Math.min(rr, gg), bb);
                max = Math.max(Math.max(rr, gg), bb);

                delta = max - min;

                // get V
                v = max;

                // get S
                if (max != 0)
                    s = delta / max;
                else {
                    s = 0;
                    h = -1;
                }

                // get H
                if (rr == max)
                    h = (gg - bb) / delta;
                if (gg == max)
                    h = 2 + (bb - rr) / delta;
                if (bb == max)
                    h = 4 + (rr - gg) / delta;

                h *= 60;

                if (h < 0)
                    h += 360;

                hsv[0][i][j] = h;
                hsv[1][i][j] = s;
                hsv[2][i][j] = v;

            }

        // histogram equalization of values (v)
```

```
         int[] hh = new int[256];
         int[] H = new int[256];
         int vvv;

         // initialization of h[]
         for (i = 0; i < 256; i++)
            hh[i] = 0;

         // Compute the histogram of values and store it in h[]
         for (i = 0; i < 400; i++)
            for (j = 0; j < 300; j++) {
               vvv = (int) (hsv[2][i][j] * 255.0);
               hh[vvv] += 1;
            }

         // Compute the cumulative histogram and store it in H[]
         H[0] = hh[0];
         for (i = 1; i < 256; i++)
            H[i] = H[i - 1] + hh[i];

         // get the scaling factor S 0.002 is k-1/m*n which is
255/400*300

         double ss = 0.002;

         // Normalize H[] with the scaling factor S
         for (i = 0; i < 256; i++)
            H[i] *= ss;

         // get the processed values array from the H[]
         for (i = 0; i < 400; i++)
            for (j = 0; j < 300; j++)

            {
               vvv = (int) (hsv[2][i][j] * 255.0);
               hsv[2][i][j] = H[vvv] / 255.0;
            }

         // HSV to RGB

         rr = 0;
         gg = 0;
         bb = 0;
```

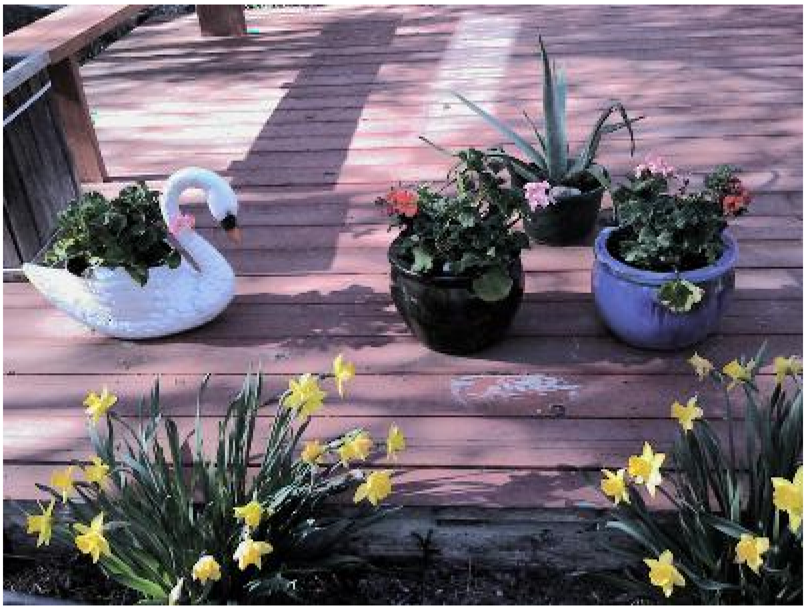
```
          for (i = 0; i < 400; i++)
             for (j = 0; j < 300; j++)

             {

                h = hsv[0][i][j];
                s = hsv[1][i][j];
                v = hsv[2][i][j];

                double c, x, m;

                // do the calculation according to the
mathematical formula

                c = (v * s);
                x = c * (1 - Math.abs((h / 60) % 2 - 1));
                m = v - c;

                if (h >= 0 && h < 60) {
                   rr = c;
                   gg = x;
                   bb = 0;
                }
                if (h >= 60 && h < 120) {
                   rr = x;
                   gg = c;
                   bb = 0;
                }
                if (h >= 120 && h < 180) {
                   rr = 0;
                   gg = c;
                   bb = x;
                }
                if (h >= 180 && h < 240) {
                   rr = 0;
                   gg = x;
                   bb = c;
                }
                if (h >= 240 && h < 300) {
                   rr = x;
                   gg = 0;
                   bb = c;
                }
```

```
                    if (h >= 300 && h < 360) {
                        rr = c;
                        gg = 0;
                        bb = x;
                    }

                    r = (int) ((rr + m) * 255.0);
                    g = (int) ((gg + m) * 255.0);
                    b = (int) ((bb + m) * 255.0);

                    image_out[0][i][j] = r;
                    image_out[1][i][j] = g;
                    image_out[2][i][j] = b;

                }

            // Write the result image_out[][]

            for (k = 0; k < 3; k++)
                for (i = 0; i < 400; i++)
                    for (j = 0; j < 300; j++)
                        out.write(image_out[k][i][j]);

        } finally {
            if (in != null) {
                in.close();
            }
            if (out != null) {
                out.close();
            }
        }

    }
}
```

The original image:



Transfer the original image from GRB model to HSV model.
Applying the histogram equalization to v which is the value in HSV.
Transfer the processed HSV color image back to GRB model.



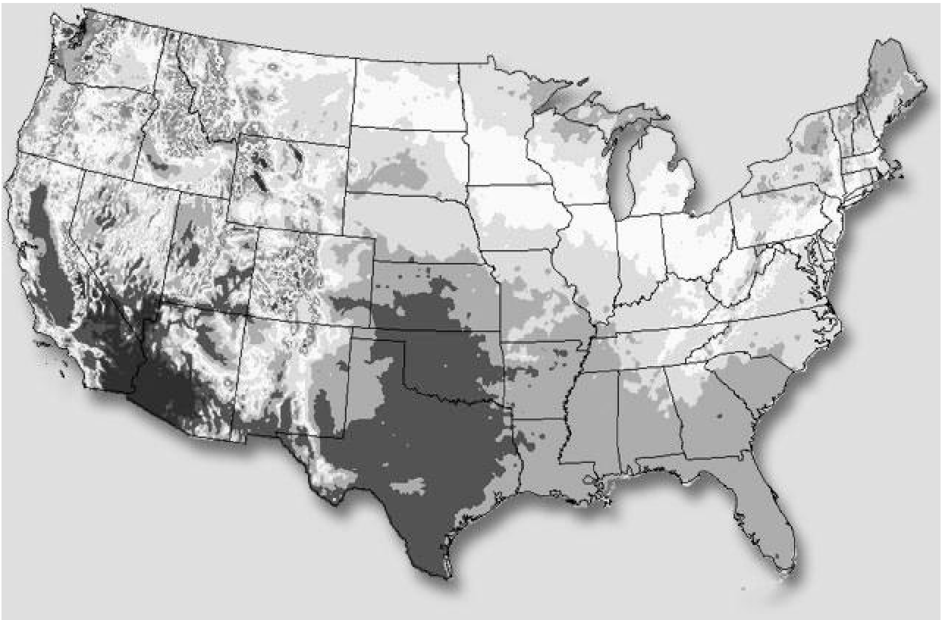
Programming 3

```
package Programming;

import java.io.*;

public class P3 {

    public static void main(String args[]) throws IOException {
        FileInputStream in = null;
        FileOutputStream out = null;
        try {
            in = new FileInputStream("C:/Users/CHAO/Desktop/tempusa.raw");
            out = new 
FileOutputStream("C:/Users/CHAO/Desktop/tempusa+.raw");
            int i, j, k;
            int[][] image_in = new int[640][420];

            for (i = 0; i < 640; i++)
                for (j = 0; j < 420; j++)
                    image_in[i][j] = in.read(); // Read the input image into 
image_in[][]

            int[][][] image_out = new int[3][640][420]; // 3 is three channels for red, 
green and blue

            int[][] table = new int[256][3]; // generate a pseudo color look-up table 
with 256 entries

            for (i = 0; i < 256; i++) // the initialization of the pseudo color look-up 
table
                for (j = 0; j < 3; j++)
                    table[i][j] = 0;

            table[0][0] = 255; // set red
            table[85][1] = 255; // set green
            table[170][2] = 255; // set blue

            // the pseudo color look-up table is a loop from red to green to blue and 
back
            // to blue
            // for the grayscale is from 0 to 255, I set the step is 3 in this pseudo 
color
            // table
            // from [255][0][0] , [252][3][0] , [249][6][0] ... to [0][255][0] and from
            // [0][255][0] , [0][249][3] , [0][246][6] to [0][0][255] and then back to
            // [255][0][0]

            // generate the color spectrum from red to green which is from
[255][0][0] to
            // [0][255][0]

            for (i = 1; i <= 84; i++) {
                table[i][0] = table[i - 1][0] - 3;
                table[i][1] = table[i - 1][1] + 3;
            }

            // generate the color spectrum from green to blue which is from
[0][255][0] to
            // [0][0][255]

            for (i = 86; i <= 169; i++) {
                table[i][1] = table[i - 1][1] - 3;
                table[i][2] = table[i - 1][2] + 3;
            }

            // generate the color spectrum from blue back to red which is from
[0][0][255]
            // to [255][0][0]

            for (i = 171; i <= 255; i++) {
                table[i][0] = table[i - 1][0] + 3;
                table[i][2] = table[i - 1][2] - 3;
            }

            // switch the grayscale image to the pseudo color image
            for (k = 0; k < 3; k++)
                for (i = 0; i < 640; i++)
                    for (j = 0; j < 420; j++)
                        image_out[k][i][j] = table[image_in[i][j]][k];

            // Write the result image image_out[][]
            for (k = 0; k < 3; k++)
                for (i = 0; i < 640; i++)
                    for (j = 0; j < 420; j++)
                        out.write(image_out[k][i][j]);

        } finally {
            if (in != null) {
                in.close();
            }
            if (out != null) {
                out.close();
            }
        }

    }

}
```

The generated pseudo color look-up table with 256 entries:

R	G	B		
255	0	0	red	i=0
252	3	0		
249	6	0		
…	…	…		
0	255	0	green	i=85
0	252	3		
0	249	6		
0	246	9		
…	…	…		
0	0	255	blue	i=170
3	0	252		
…	…	…		
255	0	0	red	i=255

The original image:



The processed image by applying the pseudo color: