

AMERICAN UNIVERSITY OF ARMENIA
College of Science and Engineering
CS 260 / 371 Theory of Computing

HW1 – Face-Specific HSV

Deadline: Sunday, June 30 2024, no later than 22:00 **SHARP**
Textbook: W. Burger, M. J. Burge. "Digital Image Processing: An Algorithmic Introduction using Java", 2nd ed., 2016
Reading: Chapter 2. ImageJ; Chapter 3. Histograms and Image Statistics; Chapter 12. Color Images, section 12.2.3. HSV/HSB and HSL Color Spaces

Task 0: Create a folder \HW1 in your repository (see **HW0.pdf**). Download individually assigned image files from the **FEI Face Database** (<https://fei.edu.br/~cet/facedatabase.html>). The files with names starting from **1** to **50** inclusive should be extracted from **originalimages_part1.zip** archive, with names from **51** to **100** inclusive – from **originalimages_part2.zip**, with names from **101** to **150** – from **originalimages_part3.zip**, and from **151** to **200** – from **originalimages_part4.zip**. Use the following algorithm to select your individual image set:

1. Compute the following three values:

$a = (\text{ASCII code of the first letter of your last name}) - (\text{ASCII code of capital letter 'A'})$;

$b = (\text{ASCII code of the second letter of your last name}) - (\text{ASCII code of letter 'a'})$;

$c = (\text{ASCII code of the first letter of your first name}) - (\text{ASCII code of capital letter 'A'})$

2. Compute an argument x :

if ($b < 2$)

$$x = a^2 + (5b)^2 + c^2$$

else if ($c < 17$)

$$x = (2a)^2 + b^2 + (3c)^2$$

else

$$x = a^2 + (2.5b)^2 + c^2$$

3. Compute a floating-point index y :

if ($b < 2$)

$$y = x^{2/3}$$

else if ($c < 17$)

$$y = 0.037x + 8.2$$

else

$$y = 6.4x^{0.41}$$

4. Switch to an integer index $start$ by rounding to the nearest integer ($y / 8$), multiplied by 8 and added 1:

$$start = (\text{int}) (y / 8 + 0.5) * 8 + 1$$

Upload in subfolder \HW1\dataset\ all images from the **FEI** database the filenames of which start from $start$ up to $start + 7$ inclusive. In all, the individual dataset will include 112 images of 8 different persons.

Task 1: Download from \Home Works subfolder of the course Moodle site the worksheet **Hist_HSV.xlsx**, and enter in **B1** cell of **Hue** worksheet the computed starting index from **Task 0**.

Create separate grayscale duplicates of each of the indicated on the **Hist_Hue** worksheet *.jpg files based on the hue, saturation and brightness values normalized from 0 to 255. Use **Image → Type → HSB Stack** command. Save the produced grayscale image stacks in *.png format using 0 digit in the file name for the hue image, 1 – saturation, and 2 – brightness. Upload the images in respective subfolders \HW1\hue\, \HW1\sat\ and \HW1\val\.

Task 2: Compute the histograms of all grayscale images created in **Task 1** and fill in the tables in **Hist_Hue**, **His_Sat** and **Hist_Val** worksheets of the **Hist_HSV.xlsx** worksheet. You are welcome to use **Analyze → Histogram** command. The cumulative histograms will be automatically computed in **Cum_Hue**, **Cum_Sat** and **Cum_Val** worksheets respectively.

Task 3: Using the computed histograms, estimate the minimal and maximal threshold values of hue, saturation and brightness for each image as to optimally extract the facial pixels. Fill in the range **B260:Z261** in **Hist_Hue**, **His_Sat** and **Hist_Val** worksheets respectively. You are welcome to use **Image → Adjust → Color Threshold** command (specify **HSB** color space).

Task 4. Repeat **Tasks 1, 2** and **3** for the product (saturation * brightness). Fill in the tables in **Hist_SV** worksheet. Implement the conversion of the color images to saturation-times-brightness-based grayscale format as an ImageJ **PlugInFilter**. Use **Color.RGBtoHSB()** static method. Upload the converted duplicates in \HW1\sv\ subfolder.

Task 5. Write an ImageJ **PlugInFilter** that extracts facial pixels using one or several thresholds from **Tasks 3** and **4**. Apply this **PlugInFilter** without modifications to each image indicated in **Hist_Hue** worksheet. In the extracted images color with white all pixels that fall beyond the applied threshold(s). Upload the extracted images in \HW1\face\ subfolder. Don't forget to upload in \HW1 folder the updated **Hist_HSV.xlsx** workbook.

Submission Conditions:

1. This is an individual assignment. Identical or similar submissions / files / results / reports / diagrams etc. will be disqualified – both the source(s) and receiver(s) will collect 0 point.
2. Group work will be accepted only if all group members are explicitly indicated in the submission. The individual contribution of each group member must also be explicitly stated, including all reasons of forming the group.
3. The submission deadline is rigidly strict. Submit even an unfinished work to get points and feedback. Late submissions will be disqualified and collect 0 point.
4. Not only precise solutions, but also free-format descriptions of ideas, difficulties, algorithms, simplifications, assumptions, etc. may be submitted.
5. You are welcome to use external sources, but all of them must be explicitly acknowledged and the links / references provided.