# Task 2

## a) Contrasts, scatterplots and correlations

The Microsoft Object Class Recognition image database holds images in different subfolders in the directory ‘msrcorid’. If the current folder contains the directory ‘msrcorid’, then each image file can be obtained with the following command in MATLAB:

imageFiles = dir(‘msrcord/\*\*/\*.jpg’)

Now, it is possible to iterate (for) over each image file and calculate the four types of image contrast formulas: *range*, *normalised* *range*, *Michelson* and *RMS*. Although, before performing the contrast calculations, the images have to be converted to a greyscale image with the following command:

L = im2gray(L);

This MATLAB function obtains the greyscale values of an RGB image by forming a weighted sum on each value in *R*, *G* and *B*. The following formula is used in MATLAB when the function im2gray() is called:

0.2989 \* R + 0.5870 \* G + 0.1140 \* B

Now the formulas for the contrast values can be applied. The following formula is used for the range contrast value (Eq. 2.1):

Eq. 2.1

The formula in Eq. 2.2 is used for the normalised range contrast:

Eq. 2.2

The formula in Eq. 2.3 is used for the Michelson contrast:

Eq. 2.3

The formula in Eq. 2.4 is used for the RMS contrast:

Eq. 2.4

The value for the *minimum luminance, maximum luminance, number of rows* and *number of columns* of an image can be obtained with the following commands in MATLAB:

minLum = min(min(L)); % Minimum luminance

maxLum = max(max(L)); % Maximum luminance

M = size(L, 1); % Number of rows

N = size(L, 2); % Number of columns

After the contrast formulas are applied on each image file in imageFiles, the six scatterplots and linear correlation coefficients can be plotted. The formula for *Pearson’s correlation coefficient* is given in Eq. 2.5:

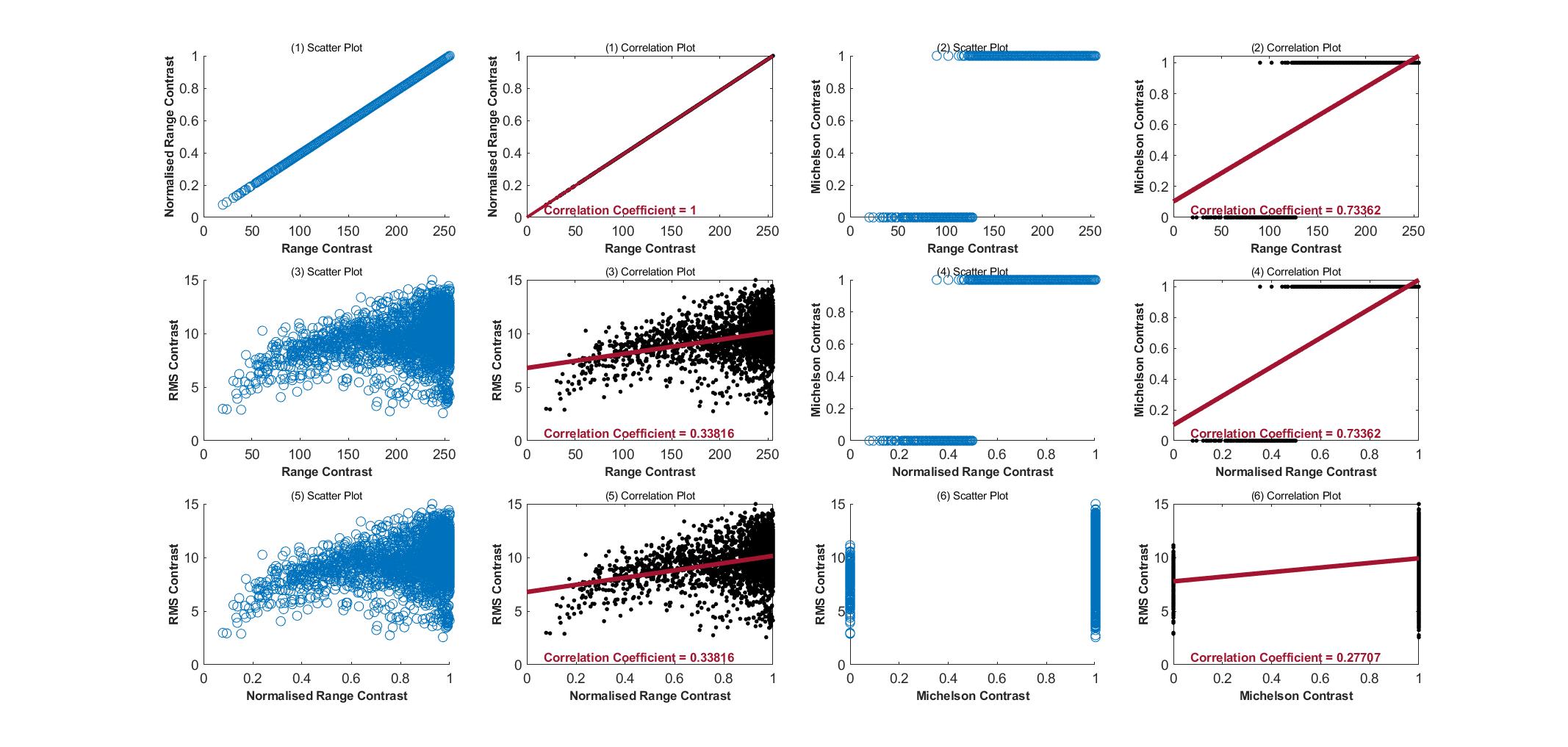
Eq. 2.5

In MATLAB, Pearson’s linear correlation coefficient is calculated using the corrcoef function, which returns a 2D-matrix. The off-diagonal entries in the matrix obtain a single value for the correlation coefficient of the variable pairs. The following code in MATLAB can be used:

r = corrcoef([x y], ‘Rows’, ‘pairwise’);

r = r(2,1);

The scatterplots and linear correlation coefficient plots are shown in Fig. 2.1 on the next page.



**Fig. 2.1:** Six pairwise scatterplots and six linear correlation coefficients based on the contrast values of each image file selected image database (image printed sidewards).

## Source Code

Source code of task2.m is added here. Visit MATLAB code for functions.

**task2.m**

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Title: Contrasts, scatterplots and correlations

% Author: Samir Habibi

% Rev. Date: 22/11/2020

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

clear; % Delete all variables.

close all; % Close all windows.

clc; % Clear command window.

% Get Microsoft Object Class Recognition image database files.

% All files in directory msrcorid and underlying subfolders.

imageFiles = dir('msrcorid/\*\*/\*.jpg');

% Create an empty array for the contrast values, length of array is equal

% to the amount of image files found.

cRange = zeros(numel(imageFiles), 1);

cNormalisedRange = zeros(numel(imageFiles), 1);

cMichelson = zeros(numel(imageFiles), 1);

cRMS = zeros(numel(imageFiles), 1);

% Set an initial counter value.

counter = 1;

% Itterate over each file and perfom calcuations.

for i = 1 : numel(imageFiles) % For each file in imageFiles

% Get the current file, path has to be defined.

currentFile = [imageFiles(i).folder '\' imageFiles(i).name];

L = imread(currentFile);

% Call functions for each contrast formula (Range Contrast, Normalised

% Range Contrast, Michelson Contrast, RMS Contrast).

cRange(counter) = getRangeContrast(L);

cNormalisedRange(counter) = getNormRangeContrast(L);

cMichelson(counter) = getMichelsonContrast(L);

cRMS(counter) = getRmsContrast(L);

% Save these values and add 1 to counter.

counter = counter + 1;

end % End if itteration over each file is done.

% Call function to get the single correlation coefficient value for two

% variables which are taken as input argument.

r1 = getCorrelation(cRange, cNormalisedRange);

r2 = getCorrelation(cRange, cMichelson);

r3 = getCorrelation(cRange, cRMS);

r4 = getCorrelation(cNormalisedRange, cMichelson);

r5 = getCorrelation(cNormalisedRange, cRMS);

r6 = getCorrelation(cMichelson, cRMS);

figure;

% Maximize user screen for original and processed images.

set(gcf, 'Position', get(0, 'ScreenSize'));

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% Create a total of 12 subplots, to hold six scatterplots and six

% linear correlation coefficient plots. See input arguments, Name-Value

% pair arguments and more for figure and text manipulations.

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

subplot(3, 4, 1);

scatter(cRange, cNormalisedRange); % Scatter plot of two variables.

title('', '(1) Scatter Plot', 'FontSize', 7);

xlim([0 255]); % Set realistic limits, not higher than pixel value 255.

xlabel('Range Contrast', 'FontSize', 8, 'FontWeight', 'bold');

ylabel('Normalised Range Contrast', 'FontSize', 8, 'FontWeight', 'bold');

subplot(3, 4, 2);

line1 = plot(cRange, cNormalisedRange, 'k.'); % Get plot points.

title('', '(1) Correlation Plot', 'FontSize', 7);

xlim([0 255]);

xlabel('Range Contrast', 'FontSize', 8, 'FontWeight', 'bold');

ylabel('Normalised Range Contrast', 'FontSize', 8, 'FontWeight', 'bold');

set(line1, 'MarkerSize', 8, 'LineWidth', 2); % Linear correlation coeff.

hold on

corrLine1 = lsline ;

% Set line options for linear correlation coefficient

set(corrLine1,'LineWidth', 2, 'Color', '[0.6350 0.0780 0.1840]');

% Display correlation coefficient value

strCorr1 = [' Correlation Coefficient = ',num2str(r1)];

textPosition = text(min(get(gca, 'xlim')), min(get(gca, 'ylim')), ...

strCorr1);

set(textPosition, 'FontSize', 8, 'VerticalAlignment', 'bottom', ...

'HorizontalAlignment', 'left', 'Color', '[0.6350 0.0780 0.1840]', ...

'FontWeight', 'bold');

subplot(3, 4, 3);

scatter(cRange, cMichelson);

title('', '(2) Scatter Plot', 'FontSize', 7);

xlim([0 255]);

xlabel('Range Contrast', 'FontSize', 8, 'FontWeight', 'bold');

ylabel('Michelson Contrast', 'FontSize', 8, 'FontWeight', 'bold');

subplot(3, 4, 4);

line2 = plot(cRange, cMichelson, 'k.');

title('', '(2) Correlation Plot', 'FontSize', 7);

xlim([0 255]);

xlabel('Range Contrast', 'FontSize', 8, 'FontWeight', 'bold');

ylabel('Michelson Contrast', 'FontSize', 8, 'FontWeight', 'bold');

set(line2, 'MarkerSize', 8, 'LineWidth', 2);

hold on

corrLine2 = lsline ;

set(corrLine2,'LineWidth', 3, 'Color', '[0.6350 0.0780 0.1840]');

% Display correlation coefficient value

strCorr2 = [' Correlation Coefficient = ',num2str(r2)];

textPosition = text(min(get(gca, 'xlim')), min(get(gca, 'ylim')), strCorr2);

set(textPosition, 'FontSize', 8, 'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left', 'Color', '[0.6350 0.0780 0.1840]', 'FontWeight', 'bold');

subplot(3, 4, 5);

scatter(cRange, cRMS);

title('', '(3) Scatter Plot', 'FontSize', 7);

xlim([0 255]);

xlabel('Range Contrast', 'FontSize', 8, 'FontWeight', 'bold');

ylabel('RMS Contrast', 'FontSize', 8, 'FontWeight', 'bold');

subplot(3, 4, 6);

line3 = plot(cRange, cRMS, 'k.');

title('', '(3) Correlation Plot', 'FontSize', 7);

xlim([0 255]);

xlabel('Range Contrast', 'FontSize', 8, 'FontWeight', 'bold');

ylabel('RMS Contrast', 'FontSize', 8, 'FontWeight', 'bold');

set(line3, 'MarkerSize', 8, 'LineWidth', 2);

hold on;

corrLine3 = lsline ;

set(corrLine3,'LineWidth', 3, 'Color', '[0.6350 0.0780 0.1840]');

% Display correlation coefficient value

strCorr3 = [' Correlation Coefficient = ',num2str(r3)];

textPosition = text(min(get(gca, 'xlim')), min(get(gca, 'ylim')), strCorr3);

set(textPosition, 'FontSize', 8, 'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left', 'Color', '[0.6350 0.0780 0.1840]', 'FontWeight', 'bold');

subplot(3, 4, 7);

scatter(cNormalisedRange, cMichelson);

title('', '(4) Scatter Plot', 'FontSize', 7);

xlabel('Normalised Range Contrast', 'FontSize', 8, 'FontWeight', 'bold');

ylabel('Michelson Contrast', 'FontSize', 8, 'FontWeight', 'bold');

subplot(3, 4, 8);

line4 = plot(cNormalisedRange, cMichelson, 'k.');

title('', '(4) Correlation Plot', 'FontSize', 7);

xlabel('Normalised Range Contrast', 'FontSize', 8, 'FontWeight', 'bold');

ylabel('Michelson Contrast', 'FontSize', 8, 'FontWeight', 'bold');

set(line4, 'MarkerSize', 8, 'LineWidth', 2);

hold on

corrLine4 = lsline ;

set(corrLine4,'LineWidth', 3, 'Color', '[0.6350 0.0780 0.1840]');

% Display correlation coefficient value

strCorr4 = [' Correlation Coefficient = ',num2str(r4)];

textPosition = text(min(get(gca, 'xlim')), min(get(gca, 'ylim')), strCorr4);

set(textPosition, 'FontSize', 8, 'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left', 'Color', '[0.6350 0.0780 0.1840]', 'FontWeight', 'bold');

subplot(3, 4, 9);

scatter(cNormalisedRange, cRMS);

title('', '(5) Scatter Plot', 'FontSize', 7);

xlabel('Normalised Range Contrast', 'FontSize', 8, 'FontWeight', 'bold')

ylabel('RMS Contrast', 'FontSize', 8, 'FontWeight', 'bold')

subplot(3, 4, 10);

line5 = plot(cNormalisedRange, cRMS, 'k.');

title('', '(5) Correlation Plot', 'FontSize', 7);

xlabel('Normalised Range Contrast', 'FontSize', 8, 'FontWeight', 'bold')

ylabel('RMS Contrast', 'FontSize', 8, 'FontWeight', 'bold')

set(line5, 'MarkerSize', 8, 'LineWidth', 2);

hold on

corrLine5 = lsline ;

set(corrLine5,'LineWidth', 3, 'Color', '[0.6350 0.0780 0.1840]')

% Display correlation coefficient value

strCorr5 = [' Correlation Coefficient = ',num2str(r5)];

textPosition = text(min(get(gca, 'xlim')), min(get(gca, 'ylim')), strCorr5);

set(textPosition, 'FontSize', 8, 'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left', 'Color', '[0.6350 0.0780 0.1840]', 'FontWeight', 'bold');

subplot(3, 4, 11);

scatter(cMichelson, cRMS);

title('', '(6) Scatter Plot', 'FontSize', 7);

xlabel('Michelson Contrast', 'FontSize', 8, 'FontWeight', 'bold');

ylabel('RMS Contrast', 'FontSize', 8, 'FontWeight', 'bold');

subplot(3, 4, 12);

line6 = plot(cMichelson, cRMS, 'k.');

title('', '(6) Correlation Plot', 'FontSize', 7);

xlabel('Michelson Contrast', 'FontSize', 8, 'FontWeight', 'bold');

ylabel('RMS Contrast', 'FontSize', 8, 'FontWeight', 'bold');

set(line6, 'MarkerSize', 8, 'LineWidth', 2);

hold on

corrLine6 = lsline ;

set(corrLine6,'LineWidth', 3, 'Color', '[0.6350 0.0780 0.1840]');

% Display correlation coefficient value

strCorr6 = [' Correlation Coefficient = ',num2str(r6)];

textPosition = text(min(get(gca, 'xlim')), min(get(gca, 'ylim')), strCorr6);

set(textPosition, 'FontSize', 8, 'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left', 'Color', '[0.6350 0.0780 0.1840]', 'FontWeight', 'bold');

## Bibliography

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