CE-712: Digital Image Processing of Remotely Sensed Data

Home assignment No. 1

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The 4 bands given in excel file are imported into MATLAB as a matrix with dimensions 16384 * 4.

```
>> uiopen('/Users/trailblazer/Documents/MATLAB/Home_Assignment1/HA_Image.xls',1)
>> |
```

Name ▲	Value
HAImage	*16384x4 table*

We have to find:

a. Mean, Mode and Median of all the bands.

Logic:

Mean is the found using (sum of all numbers)÷(number of numbers - 1). -1 is included to make the mean unbiased towards the data.

Mode and **Median** are easily found if data is sorted. Thus in the first step, we are using sort function to sort the data.

- The numbers are counted if number does not change. elseIf the number changes, counter is reset. Only if the previous counter was greater than mode count, mode is updated.
- For median the middle value is taken from sorted data. If exact middle cannot be found, 2 numbers in the middle are averaged to get median.

b. Standard deviation of all bands.

Logic:

Standard deviation is taken as square root of variance of numbers.
The variance of numbers is taken from part c.

c. Covariance-variance matrix

Logic:

A combined logic can be said when we think variance as a covariance of the same set of matrix taken.

Covariance of a matrix is formulated as: $$q_{jk} = \frac{1}{N-1}\sum_{i=1}^{N}\left(X_{ij}-\bar{X}_j\right)\left(X_{ik}-\bar{X}_k\right)$$

We store the values found in a 4*4 matrix. We are taking the mean we get in part (a). This matrix is called variance-covariance matrix.

Q.2 Linear stretching of bands.

Logic:

As the name suggests, linear stretching of bands means we are finding the least value and maximum value and then scaling the values of matrix accordingly.

Mathematically, linear stretching can be described as:

$$DN_{st} = 255 \times \frac{(DN - DN_{min})}{(DN_{max} - DN_{min})}$$

After linear stretching, operations done in part (a) of Q.1 are repeated.

Q.3 Cube and apply linear transformation

Logic:

The given digital numbers are cubed and stored in a new array. Now, as digital numbers > 255, linear compaction to be done. As concept of linear stretching depends on straight line, the same formula holds true for linear compaction.

Hence, the combined concept of Q.1 and Q.2 is used in Q.3.

- To avoid dealing with large number of variable, similar types of variables are grouped and stored in an array.

Results:

Q.1

mean

1x4 double

1	2	3	4
100.9686	68.6102	68.1210	121.1852

median

1x4 double

1	2	3	4
101	69	68	123

stdDev

1x4 double

1	2	3	4
5.8888	6.2634	6.8261	11.7207

mode

1x4 double

1	2	3	4
102	49	40	76

var_cov

4x4 double

1	2	3	4
34.6783	33.0131	11.1864	48.8620
33.0131	39.2300	9.7939	53.9054
11.1864	9.7939	46.5953	33.2938
48.8620	53.9054	33.2938	137.3745

variance

1x4 double

1	2	3	4
34.6783	39.2300	46.5953	137.3745

Q.2

mean

1x4 double

1	2	3	4
101.8219	63.2986	81.4869	181.5984

median

1x4 double

1	2	3	4
102	64.5570	81.1364	185.6579

stdDev

1x4 double

1	2	3	4
33.3700	20.2173	19.7801	26.2173

mode

1x4 double

1	2	3	4
107.6667	0	0	80.5263

var_cov

4x4 double

1	2	3	4
1.1136e...	603.8479	183.6853	619.3475
603.8479	408.7375	91.6060	389.2069
183.6853	91.6060	391.2522	215.8022
619.3475	389.2069	215.8022	687.3481

variance

1x4 double

1	2	3	4
1.1136e...	408.7375	391.2522	687.3481

Q.3

mean

1x4 double

1	2	3	4
126.4218	40.2240	39.5811	127.6775

median

1x4 double

1	2	3	4
125.2620	39.9183	38.2064	129.9164

stdDev

1x4 double

1	2	3	4
22.0231	10.8278	12.1925	34.8356

mode

1x4 double

1	2	3	4
129.0206	14.2760	7.7518	30.6334

var_cov

4x4 double

1	2	3	4
485.0168	212.5405	66.0401	535.7379
212.5405	117.2408	26.8157	273.8874
66.0401	26.8157	148.6567	155.8774
535.7379	273.8874	155.8774	1.2135e...

variance

1x4 double

1	2	3	4
485.0168	117.2408	148.6567	1.2135e...

Conclusion:

Any kind of operations (taken an example of scaling here) has a noticeable effect on the statical elements.

- When we linearly stretch the data, the variance is increased by a factor square of slope of stretching. This means that if we know the initial variance, initial and final standard deviation, we can calculate the final variance for this data.

Mathematical support:

$$\sigma^2 = \frac{\sum_{i=1}^{n} (x_i - x)^2}{n-1}$$

Linear stretching → Matrix m. (factor).

$$\sigma_n^2 = \frac{\sum_{i=1}^{n} (m x_i - m\bar{x})^2}{n-1}$$

($\because$ $\bar{x}$ will also be stretched)

$$\Rightarrow \sigma_n^2 = m^2 \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}$$

$$\boxed{\begin{array}{c} \sigma_n^2 = m^2 \sigma^2 \\ \sigma_n = m\sigma \end{array}}$$

- The above explanation cannot be applied to mean, median and mode mainly because of the data being seen very differently by the 2 groups of statistical tools.
- For the case of exponential operations, this highly depends on how the data is skewed and is difficult to predict without knowing the nature of data.