2016bihistogramequalizationtwo plateau limits (BHE2PL)

Estudar o parágrafo “**4 Proposed method**”

**4 Proposed method**

The idea of the new method of equalization is to use a total of

four plateau limits, two plateau limits for each sub-histogram

instead of the six plateau limits used in [6], three plateau

limits for each sub-histogram.With the removal of these two

limits what we want to achieve is to reduce the brightness

difference between the input image and the resulting image,

while still achieving an improvement in the image contrast.

The proposed method is named bi-histogram equalization

using two plateau limits (BHE2PL).

The first step wewould takewould be proceeding to calculate

the expected average intensity SP of the global histogram

of the image (see Fig. 1) given by the equation:

Equation (8)

Once the SP value has been calculated using Eq. (8), the

histogram is split into two sub-histograms, the lower subhistogram

*H*L and the upper sub-histogram *H*U. *H*L contains

the values of intensities found from the minimum gray level

in the image *l*MIN up to the average intensity SP, while *H*U

contains the values of intensities found from SP + 1 up the

maximum gray level in the image *l*MAX (see Fig. 2). *l*MIN is

the lowest effective intensity within the image, i.e., the lowest

intensity in the histogram that appears at least once in

the image, likewise *l*MAX represents the maximum effective

intensity found in the image, i.e., the highest intensity within

the histogram that appears at least once in the image. After

the global histogram has been divided, the plateau limits

PL’s for each resulting sub-histogram are calculated. Basically,

each plateau limit is calculated using the following

formula:

Equation (9)

where *R* is a coefficient with a value between 0 and 1, and

*Pk* represents the peak in the histogram given by:

Equation (10)

In thiswork, the values of the PL’swill be selected using local

information obtained from the input histogram. One way to

extract information from the input histogram is to use the

gray-level ratio GR for each obtained sub-histogram. Since

GR is a value between 0 and 1, it replaces *R* in Eq. (9), GR

being the value used to represent the level of improvement

that needs to be applied. The lowpercentages of improvement

are applied at lowrates of gray, likewise, the high percentages

of improvement are applied at high rates of gray. Given the

GR’s use as coefficients, the plateau limits can be calculated

as:

Equation (11) 12-13-14

where *Pk*L is the maximum intensity peak for the lower subhistogram,

PLL1 and PLL2 are the lower and upper limits

of the lower sub-histogram, likewise *Pk*U is the maximum

intensity peak for the upper sub-histogram, PLU1 and PLU2

are the lower and upper limits of the upper sub-histogram.

The gray-level proportions of the lower sub-histogram GRL1

and GRL2, and the gray-level proportions of the upper subhistogram

GRU1 and GRU2 are defined as:

Equation (15) 16-17-18

where SPL and SPU are the average intensities of the lower

and upper sub-histograms, respectively, *D*L and *D*U are differences

in the gray-level proportions of the lower and upper

sub-histograms, respectively. SPL and SPU are calculated as:

Equation (19) -20

where *N*L and *N*U are the total number of pixels that are in

the sub-histogram of the lower and upper part. *D*L and *D*U

are calculated as follows:

Equation (21) -22

Figure 3 shows the histogram with the respective plateau limits

found. Thereupon, the shape of the histogram is modified,

for the lower sub-histogram *(l*MIN ≤ *k* ≤ SP*)*, as follows:

Equation (23)

This means that for values in the lower sub-histogram that

are less than or equal to PLL2, the sub-histogram is modified

with the PLL1 value, if this value is greater then the value of

PLL2 is used.

Likewise for the upper sub-histogram *(*SP + 1 ≤ *k* ≤

*l*MAX*)*, the sub-histogram is modified as follows:

Equation (24)

The modified histogram is shown in Fig. 4. Once the histogram

modification process is finished each sub-histogram

is equalized independently according to Eq. (6).

