INFORMATION SYSTEM FOR ANALYSING IMAGES USED IN THE DIAGNOSIS OF GASTRIC ADENOCARCINOMA

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Abstract- The primary goal of this works is develop a system, to identify lesions of Gastric adenocarcinoma, by using a technique proposed here, which distinguishes injuries by color filtering and subsequent calculation of the dimensions and color saturation of the lesion, to identify whether it is an injury: Severe, medium or mild. To issue a pre-diagnosis.

Keywords -Image processing ,Gastric adenocarcinoma , clinical diagnosis

I. INTRODUCTION

Cancer is currently regarded as the biggest health problem worldwide, is considered as the second place of mortality. Gastric adenocarcinoma or stomach cancer is considered a neoplasia disease very often in the world, throwing figures of over half a million deaths per year, representing more than 8%[1].

There are different tools that help for adenocarcinomadetection some of them are: Endoscopy/endoscopic ultrasound (EUS), Computer tomography (CT)and/or positron emission tomography (PET). The aim to evaluate the accuracyof the tools used for detection can be seen in the work of K.Parry[2]**,** his conclusion is EUS is superior to CT in determining nodal status and tumor localization in GEJ tumors.

In the endoscopy, there are the technology called Narrow Band Imaging (NBI) is a powerful optical image enhancement technology that improves the visibility of blood vessels and other structures[3].

White light is made up of an equal mixture of wavelengths. Lengths shorter wavelengths only penetrate the upper layer of the mucosa, while the lengths of longer wavelengths penetrate deep into the mucosa. The NBI light consists of two specific wavelengths that are absorbed by hemoglobin.

The length wavelength light in NBI is 415 nm, which penetrates only the surface layers of the mucosa. This is absorbed by the capillaries on the surface of the mucosa and shows brownish spots on the video image. This wavelength is particularly useful for detecting tumors that are highly vascularized often. The second length of NBI light wave is 540 nm, which penetrates deeper than 415 nm light. It is absorbed by the blood vessels located deep in the layer of the mucosa and appear in the NBI cyan image. This wavelength allows a better understanding of the vascularization of suspicious lesions.[3].

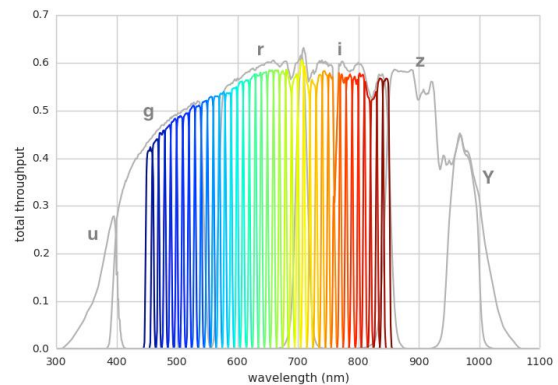In order to better understand this, Figure 1 is shown, where the wavelength of the colors is exemplified

Figure 1. Wavelength colors (Source: Pau Camera)[4].

Currently there are several methods of diagnosis or complementary tests to diagnose cancer [5-8]. While advances in the understanding of cancer new tools are developed and existing ones refined. The correct diagnosis of location and extent of disease allows the physician to choose the right treatment: surgery, chemotherapy and / or radiotherapy.

This research aims to develop aninformation system to assist in the clinical diagnosis, detection and treatment of gastric adenocarcinoma or stomach cancer. With a systemic and systematic approach based on the characterization and statistical analysis of the images.

This document is composed as follows: Section 1 we show the most usual steps from processing an image to its corresponding classification, explaining briefly but substantial methods and basic concepts used. Section 2 we present our proposal based on the concentration of colours for the identification of any area affected by carcinoma. Section 3. We present a method to classify lesion by intensity, finally, the conclusions.

Image processing.

The function of this system is acquire, prepare and analyse images obtained by the process of endoscopy, and provides a pre – diagnostic of adenocarcinoma. During the images analysis optimization or artificial intelligence techniques are

used. At the moment, the system cannot analyse video, but this option is considered for future work.

The figure 2, show a first approach to solve process.

Figure 2.Global solution or image process.

The Pre-process section can divide into Decompression and Noise reduction as you can see in the Fig 3. In the case of receive a JPEG (Joint Photographic Experts Group)[9] image decompression is active or may be omitted if a non – compressed image is received.
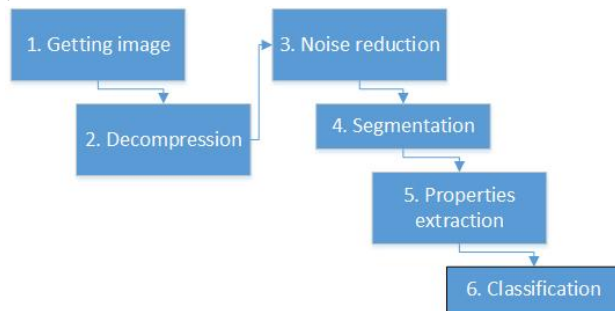.

Figure 3. Image process

1. Getting image.

Usually the image acquisition is through a process called: endoscopy, which is to look and examine inside the body by a flexible tube with a tiny camera and a light on the end, this instrument is called endoscope. An endoscope is inserted through a natural body opening or small cut. Endoscopy is usually used to examine and treat some parts of the gastrointestinal tract [10].

In this section, we determine what type of image, we support exists a lot of formats, for example: JPEG, BMP, TIF, GIF, PNG, etc, however it is considered that the images must be of good resolution.

It has chosen to use the JPEG format(Joint Photographic Experts Group) The JPEG standard (ISO/IEC 10918) was created in 1992 (latest version, 1994) [10].The JPEG compression algorithm is very good in cases of photographs and paintings of realistic scenes with smooth variations of tone and colour.

JPEG uses a lossy form of compression based on the discrete cosine transform (DCT). This mathematical operation converts each frame/field of the video source from the spatial (2D) domain into the frequency domain (a.k.a. transform domain).

The JPEG standard actually includes a lossless coding mode or quality level, in this research is very important because it should not be used in scenarios where the exact reproduction of the data is required (such as some scientific and medical imaging applications if lost details.

2. Decompression.

Decompression is required if the image is of the type jpeg, but it is simple with the use of certain computational tools which are discussed later.

3. Noise reduction.

A goal in filtering images is to eliminate noise in the image in such a way that the original image is more understandable. A suitable approach is to smooth the image[11]. But in the proposal of this paper was omitted, but it would be in future works.

4. Segmentation.

The first is to detect the borders of objects to be analyzed for this you can use a segmentation or thresholding methods, for example: Bernsen [12], Contrast, Mean, median, [13], Niblack [14], Otsu [15,16], Phansalkar [17], Sauvola, JSEG[18].

5. Properties extraction

From detection of the border it is possible to extract characteristics as regards how it is the case of: area, diameter, skewness and compactness. Subsequently the texture and color work, by dividing clinically important regions by the transform method and the Euclidean distance by the method of co-occurrence matrices GLCM (Gray-Level Co-occurrence Matrix GLCM) [19].

Estimates image properties related to second order statistics, each entry (i,j) in GLCM corresponds to the number of occurrences of the pair of gray levels *I* and *j* which are a distance *d* apart in original image.

In order to estimate the similarity between different gray levels co-occurrence matrices, Haralick propose statical features extracted from them.

GLMC is a well know method for analyzing texture images. [20]. However, it is important that the use of Gabor wavelet features considered. GLMC. A statistical method of examining texture that considers the spatial relationship of pixels is the gray-level co-occurrence matrix (GLCM), also known as the gray-level spatial dependence matrix. The GLCM functions characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix. (The texture filter functions, described in Texture Analysis cannot provide information about shape, i.e., the spatial relationships of pixels in an image.)[21]

6. Classification

After it follows the classification for which can be used support vector machines SVM (Support-Vector-Machines) and K-NN classifier. That is a methodological approach to classification of dermatological images.

II. PROPOSAL

Our proposal is divided into two parts: The first will be to work the endoscopic image to generate an inverted image, as an image that marks the lesion in red and the rest in black. The second determine by RGB technique and the arithmetic mean, the degree of the lesion.

Identify the lesion

For the part one we propose the next methodology as can see in the figure 4.
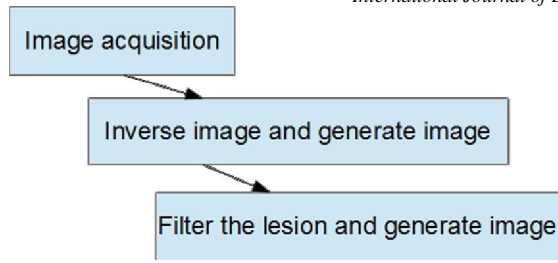
Figure 4. Proposal

Development of computer application has opted to use the PHP language, since it is flexible and has the necessary libraries to process graphics specifically GD graphics are used.
For this the following steps:

Image adquisition

Image is provided in jpg format to the software, to process it, the *imagecreatefromjpeg (...)* PHP function is used, that is included in PHP version 5 to 7. Check the next code.

$image = imagecreatefromjpeg('my_image.jpg');

This creates a *$image*variablethat establishes a link to the physical file.

Image is provided in jpg format to the software, to process it, the *imagecreatefromjpeg (...)* PHP function is used, that is included in PHP version 5 to 7.

Before continuing briefly describe what is a digital image, an image has certain properties, one of them is having dimensions: Height and width; also has image quality, format. Each color point in the image is known as a pixel, and each pixel is representable in a matrix of points with coordinates (x, y) or (i, j) for giving other nomenclature therefore can be worked as matrices and they are represented as shown in expression 1.

$$Image = \begin{bmatrix} pixel_{1,1} & \cdots & pixel_{1,n} \\ \vdots & \ddots & \vdots \\ pixel_{m,1} & \cdots & pixel_{m,n} \end{bmatrix} \quad (1)$$

Each pixel is composed of three basic colors RGB (Red - Green - Blue) and something called alpha.

Inorder to analyze each of the pixels of the image we proceed to the construction of a nested array for touring the whole cycle, as show in the table 1:

Table 1. Nested cycle

```
$width = imagesx($image);  // width in pixels
$height = imagesy($image);  // height in pixels

for($x=0; $x < $ width; $x++)
        for($y=0; $y <$ height; $y++)
        {
                //Process
        }
```

It is important to mention that the image analysis is delayed, since many pixels have to be processed, for example of the sample image represented in figure 5, the total pixels to be processed by the cycle of table 1 are 337110.

To access the information pixel is used the following PHP function.

$index = imagecolorat($image, $x, $y);

If PHP use GD library 2.0[22] or higher an image is a true color, this function return RGB value, the value returned is an integer which contains Red, Green and Blue component values. To access to each color is necessary bit shifting and masking this value. The size is 4 if have alpha component is include, and 3 bytes if is omitted.

To obtain individually colors, there are two methods:
1. Use imagecolorsforindex(…, …) PHP function.
2. Bitshifting and masking this value.

imagecolorsforindex(…, …)

To better appreciate operation an example is shown below:

$rgb = imagecolorsforindex($image, $index);

As you can see this function receive two parameters: first is the image resource, the second is the composed number that include alpha component and colors, both previously acquired. Return am array with four values as follows: array={ 'Red', 'Green', 'Blue', 'Alpha' }, with their respective values. The access to values is like:

$rgb[red], $rgb[green], $rgb[blue], $rgb[alpha]

Bit Shifting

To convert manually the value returned, is necessary the next process. First should be considered if the image brings or not the Alpha component. If not contained,the number include three colors, each occupy 8 bits, the first 8 bits correspond to Red color, the following 8 to Green and the last 8 bits of Blue, having in total 8 * 3 = 24 bits, to extract is necessary bit shifting to right followed by the AND (&) operation.Each colorcan take a value in the range of 0 to 255 color = {0, .., 255} therefore the maximum value is 255, and that number can be represented by 8 bits since this is equivalent to binary number (11111111). Which also corresponds to the hexadecimal value (FF).

Must be stored in independent variables each color, for this the following code shows:

$r = ($index>> 16) & 255;
$g = ($index>> 8) & 0xFF;
$b = $index& 0xFF;

The variable $r represents the red color, in the same context the other variables, $index >> 16 indicates that the value of this variable will make a bit shift bit to the right of

16 positions, to better illustrate this, gives a value to $ index = 8399890, this binary number is[23]:
1000000000010110000010010

After apply bit shift
0000000000000000010000000 = 128|$_{dec}$

Now apply the (&) operator with 0xFF
00000000000000010000000
00000000000000011111111 = 0xFF = 255|$_{dec}$

00000000000000010000000 = 128|$_{dec}$

Which in the practice does not alter the solution, then it is concluded that the value of $r is 128, and represent the color red

For the $g = ($index >> 8) & 0xFF; is similar
1000000000010110000010010
00000000010000000000101100 -> 32812|$_{dec}$

Now apply the (&) operator with 0xFF
00000000100000000000101100
00000000000000000011111111

00000000000000000000101100 -> 44|$_{dec}$

As you can see the operator (&)is to set 0 into bits in the position in the range {24, 9}, but leaving intact the other value. Leaving the value of $g or Green decimal number 44.

For $b variable is similar de procedure, obtaining $b=18.

Here are three examples of integers returned by the function *imagecolorat (..)*,They hasbeen processed by two methods, in which both has obtained the same results.

8399890: Array ([red] => 128 [green] => 44 [blue] => 18 [alpha] => 0)

8531476: Array ([red] => 130 [green] => 46 [blue] => 20 [alpha] => 0)

8728342: Array ([red] => 133 [green] => 47 [blue] => 22 [alpha] => 0)

8399890: Bit Shift: int(128) int(44) int(18)
8531476: Bit Shift: int(130) int(46) int(20)
8728342: Bit Shift: int(133) int(47) int(22)

The resulting image is displayed, to see which is loaded correctly. To do this the basic PHP code is presented below.

```
header('Content-type: image/jpeg');
$image = imagecreatefromjpeg('my_image.jpg'');
imagejpeg($image);
```

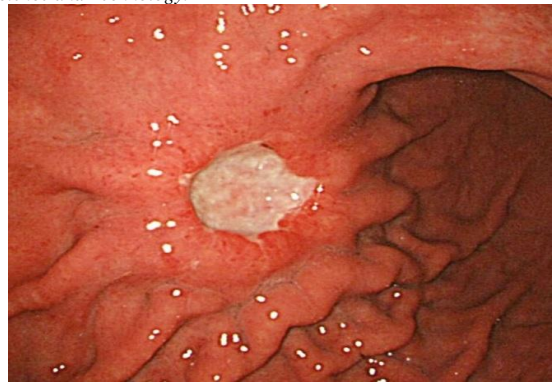The result is as follows in the figure 5:

Figure 5. Image retrieved from jpg format.

Inverse image

The next step is inverse the colors,the purpose of reversing the colors of the image is to highlight lesions for better appreciation to the specialist. For the system is not necessary, but in this release, we use the image inverse to identify the lesion.

There are two methods to do: use function imagefilter($im, IMG_FILTER_NEGATE); and do it manually. Both methods are presented below.

Use imagefilter(…, …);

This is very easy, only two lines of code are necessary.

```
$image = imagecreatefromjpeg('my_image.jpg');
imagefilter($image, IMG_FILTER_NEGATE);
```

After this process the resource image ($image) has been modify, if it's displayed look like figure 6. Imagefilter() function is included into GD library. The option is IMG_FILTER_NEGATE.
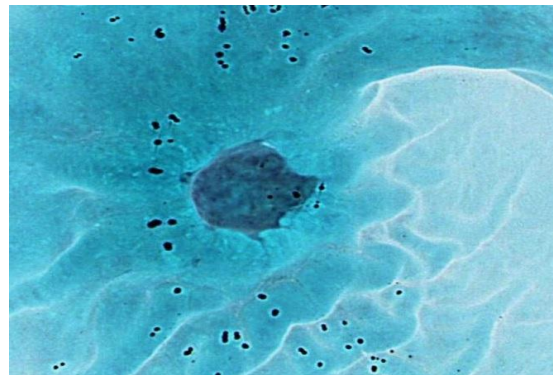

Figure 6. Image inverse.

This process is to separate pixel colours in three variables R, G, B and then individually extract each value, the value obtained must be subtracted from 255 value, and the resulting value is set as the new value of the pixel. As follow

```
$color = imagecolorallocate($im, 255-$rgb['red'], 255-$rgb['green'], 255-$rgb['blue']);
imagesetpixel($image, $x, $y, $color);
```

Filter lesion

The system must show figure5 and figure 6 together for visual analysis, in this proposal to distinguish the lesions we use the inverse image.

Is necessary a complete analysis of the image, to do this you can use the codeof cycle nested, previously show in table 1. In this process an analysis of each pixel is made, as was done previously, here pixel colors are separated into R, G and B, filtering pixels that meet the following condition becomes

1. Red < 100
2. Green < 100
3. Blue >100

The three conditional must be true in PHP code appears like this

if(($R<100) && ($G < 100) && ($B > 100))

Where:
$R – Represent Red component
$G – Represent Green component
$B – Represent Blue component

In the next PHP code show the code to recognize the lesion,

```
if(($R<100) && ($G < 100) && ($B > 100))
{
$color = imagecolorallocate($im, 255, 0, 0);
imagesetpixel($im, $x, $y, $color);
}
else
{
 $color = imagecolorallocate($im, 0, 0, 0);
imagesetpixel($im, $x, $y, $color);
}
```

Where components RGB are:
  R:255, G:0, B:0 are Red color
  R:0, G:0, B:0 are Black color

The objective is to simplify the lesion, red paint the injury, and the rest in black. After apply a filter a new image is obtained as you can see in the figure 7.
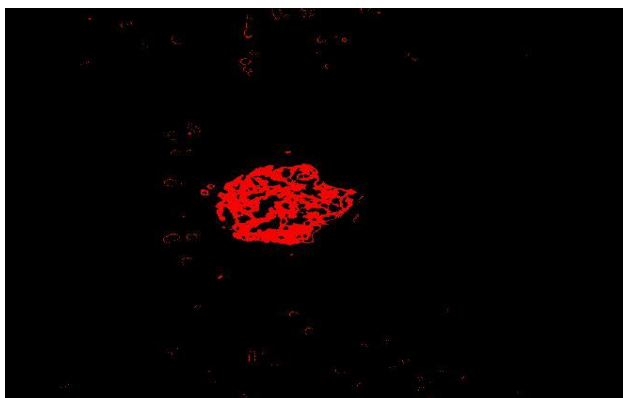

Figure7. Lesion colored in red

Here you have to observe that there is noise, since the lesion is located in the centre, in future work it will have to apply a filter to remove that noise.

At this time, there are three images (figure 4, figure 5, figure 6), each an evolution of the previous one,until now the original image has been transformed three times, but here is where a question arises, should keep the two changes to the original image, or whenever you want the images process, they must be recalculated, to make a correct decision should consider the following conditions:

- How much time is necessary for the calculation of the resulting images?
- Do you have a database manager, to store images?

To resolve the first question, the processing time of each image is calculated in order to determine whether it is appropriate constantly calculate the new image.

In order to be more precise, in the times to be calculated, the fact remains that tests run on a machine with an Intel i5 to 2.8Ghz with 8GB of memory, PHP version 7, Windows 8.

The time elapsed to obtain the inverse image has been 0,53 seconds, the time during the calculation and generation of two images (inverse and lesion detection) including jpg generation time of the last image file has been 0,69 seconds. As can be seen the calculation time is little in practical terms, since usually few images are processed, giving as a viable option to generate the images when required.

Now we proceed to the second question, which results from the decision of the first question, if the first option was determined that images of intermediate processes would be saved, then two options are:

- Save intermediate images as jpeg files
- Save intermediate images as data in a table of database.

The answer is simple if you do not have a database manager, save intermediate images as files, but in the case two, you can save images as jpeg files, and location in a database, or save images as data into a table. Suppose save data into table was select then we propose the next solution.

Figure 8. Table Images

From de fig.7, *img_id* represent identifier for a endoscopic image, *img_x*, *img_y* there are the coordinates, and the *img_Red, img_Green, img_Blue*, the color components

We have to work with the nested cycle from the code into the table 1, as noted above, the code where you can access each specific pixel of the image was shown, and can be modified, for it alone was enough to have the (x,y) position and there is obtained and the colors was extracted, with that information can be saved in an array or table information later this information can be reconstructed image, in Figure 7, shows the structure proposed for the table.

Determine the degree of the lesion

Now the proposal to determine the degree of the injuryis presented.

After processing an image, part of this process is taken to work a sample of 35 images with the purpose of determining a range of values to classify lesions in three grades: slight, medium or severe.

The proposal presented here uses RGB and some statistical techniques to look for ranges of colors based primarily on the green component, as well as blue, to locate the degree of the lesion.

The first step of the proposal is to determine the minimum and maximum values of the three colors (RGB) of the total pixels of each endoscopic image of the sample being analyzed, to show this see the next SQL.

The next code is to obtain max values:

SELECT max(img_Red), max(img_Green), max(img_blue) FROM images GROUP BY img_id;

The values obtained are show in table 2.

Table 2. Max values (Blue)

Id	Red	Green	Blue
Id01	87	99	191
…	…	…	…
Id35	99	99	120

The next code is to obtain min values:

SELECT min(img_Red),
    min(img_Green),
    (img_blue)
 FROM images
GROUP BY img_id;

The values obtained are show in table 2.

Table 3. Min values (Green)

Id	Red	Green	Blue
Id01	0	12	101
…	…	…	…
…	…	…	…
Id35	43	74	101

Obtained values from table 2 and table 3, we proceed to calculate color percentage with the equation 1 denoted by:

$$V_{max\,|\,min} = \frac{V_{color}}{\sum_{i=1}^{3} R,G,B} \quad (1)$$

Where:

V_{color} -Color value
R -Max pixel value to Red color
G - Max pixel value to Green color
B -Max pixel value to Blue color

Now we proceed to calculate max values, derived from equation 1, obtain.

$$V_{Rmax} = \frac{Red}{\sum_{i=1}^{3} R,G,B} \quad (2)$$

Consider Table 2, except for column one and pass the values to a matrix of 35 * 3 denoted by A, we have equation:

$$A = \begin{bmatrix} 87 & 99 & 19 \\ \vdots & \vdots & \vdots \\ 99 & 99 & 12 \end{bmatrix} \quad (3)$$

We now replace the values of (3) in equation (2) and obtain equation 4, for row 1 we have:

$$V_{Rmax} = \frac{a_{1,1}}{\sum_{i=1}^{3} a_{1,i}} * 100 \quad (4)$$

$$V_{Rmax} = \frac{87}{87+99+191} * 100 \quad (5)$$

$$V_{Rmax} = 23.1\% \quad (6)$$

Now the maximum values for the other two colors are calculated, so that intermediate results are omitted and only the final result is presented:

$$V_{Cmax} = \frac{99}{\sum_{i=1}^{3} 87+99+191} * 100 = 26.3\% \quad (7)$$

$$V_{Bmax} = \frac{191}{\sum_{i=1}^{3} 87+99+191} * 100 = 50.6\% \quad (8)$$

In this way the respective percentages of max colors that compose each image are calculated, this process is performed for each and every one of the images of the total of 35 that are processed.

Now that process is done for the minimums as seen below:

$$V_{Rmin} = \frac{a_{1,1}}{\sum_{i=1}^{3} a_{1,i}} * 100 \quad (9)$$

$$V_{Rmin} = \frac{0}{0+12+101} * 100 = 0\% \quad (10)$$

$$V_{Gmin} = \frac{12}{0+12+101} * 100 = 10.6\% \quad (11)$$

$$V_{Bmin} = \frac{101}{0+12+101} * 100 = 89.4\% \quad (12)$$

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Inthis way the respective percentages of min colors that compose each image are calculated, this process is performed for each and every one of the images of the total of 35 that are processed.

Nowthat process is done for the mins colours as seen in table 4.

Thetable 4 was divided into 3 sections, defined in a first version of empirical form, that in future works will be redefined to make more precise the method.

Now the arithmetic mean calculation is defined by 13.

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i = \frac{x_1 + x_2 + \cdots + x_n}{n} \qquad (13)$$

Calculate the arithmetic mean for the values of the three sections of table 4.

$$\bar{x}_s = \frac{1}{7}\sum_{i=1}^{7} x_i = \frac{x_1 + x_2 + \cdots + x_7}{7} \qquad (14)$$

$$\bar{x}_m = \frac{1}{24}\sum_{i=8}^{31} x_i = \frac{x_1 + x_2 + \cdots + x_n}{24} \qquad (15)$$

$$\bar{x}_l = \frac{1}{4}\sum_{i=32}^{35} x_i = \frac{x_1 + x_2 + \cdots + x_n}{4} \qquad (16)$$

Where
$\bar{x}_s$ Mean arithmetic for Severus lesion
$\bar{x}_m$ Mean arithmetic for medium lesion
$\bar{x}_l$ Mean arithmetic for light lesion

From 14 equation obtain.

$$\bar{x}_s = \frac{1}{n}\sum_{i=1}^{7} x_i = \frac{12 + 10 + 16 + 12 + 0 + 10 + 12}{7}$$

$$\bar{x}_s = \frac{12 + 10 + 16 + 12 + 0 + 10 + 12}{7}$$

$$\bar{x}_s = \frac{12 + 10 + 16 + 12 + 0 + 10 + 12}{7}$$

$$\bar{x}_s = 10.28 \qquad (17)$$

Calculate the arithmetic mean for the remaining two sections by obtaining the following data.

$$\bar{x}_m = \frac{1}{24}\sum_{i=8}^{31} x_i = 47.25 \qquad (18)$$

$$\bar{x}_l = \frac{1}{4}\sum_{i=32}^{35} x_i = 76.25 \qquad (19)$$

Table 4. Min values for Green divided in 3 sections. (Source: Alcaide[24])

Id Image	Max per image Green (x)	Percentage of Green
Id01	12	11%
Id02	10	9%
Id03	16	14%
Id04	12	11%
Id05	0	0%
Id06	10	9%
Id07	12	11%
Id08	43	30%
Id09	27	21%
Id10	34	25%
Id11	38	27%
Id12	49	33%
Id13	59	36%
Id14	33	25%
Id15	22	18%
Id16	58	36%
Id17	49	33%
Id18	73	42%
Id19	42	29%
Id20	27	21%
Id21	43	30%
Id22	39	28%
Id23	43	30%
Id24	55	35%
Id25	57	36%
Id26	65	39%
Id27	59	37%
Id28	63	38%
Id29	55	35%
Id30	64	39%
Id31	37	27%
Id32	66	40%
Id33	80	44%
Id34	85	42%
Id35	74	34%

In order to determine the type of lesion in question, the opinion of the specialists is taken so that we are told how they recognize an injury, whereby the following criterion is obtained which indicates that:

The percentage of yellow color in an endoscopy is an indicator of degree of the lesion, however it can be observed that until the moment it is not counted directly with the yellow color, since only Red, Green and blue are counted in That understood will work with the color green.

For this purpose, it is proposed in this first advance that the slight injuries are those that contain more green component and the lightest green component or otherwise said.

A diagnosis of a severe lesion ranges from 0 to 10 in the minimum green value, while in the blue maximum it ranges from 170 to 255; For a median lesion we have the minimum values in green of 11 to 47 and the maximums in blue of 128 to 251; Finally for mild injuries the minimum green ranges are 48 to 76 and in the case of blue highs they are of 118 to 137, for the case where there is no risk it suffices that the minimum green value is greater than 76.

III.CONCLUSIONS

The result of the proposal to generate some values to be able to classify the injuries is summarized in the table 5.

Table 5. Values for lesions

Lesion type	Range	% color Green
Severe	0-10	10%
Medium	11-47	33%
Slight	48-76	40%
Without risk	>76	>40%

Although green is very representative, one must also consider blue, which is why table 2 is calculated, as well as equations 6, 7 and 8.

This work has been extensive, but there is a lot of work to develop, since Table 4 where 3 sections were obtained was done empirically, and it has to be done by a scientific method, to optimize the classification of images.

ACKNOWLEDGMENT

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