Computer-aided System for the Bruise Color's Recognition

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Abstract:

The definition a moment of the trauma receiving - result of blunt force, is very important for the forensic medicine. The analysis is made visually of these kind traumas for alive human and it depends on a forensic physician experience. The changes of trauma colors suggest that the time interval will be approximately defined. It is made an examination of large number papers in this aria. In the work is proposed the summary set of trauma colors in a graph description, relations between them and their different sequences in the time.

The computer apply is very comfortably for investigation of trauma picture. A statistical investigation is suggested to get RBG – components of variety trauma colors. For this purpose is created a computer software with which is possible to calculate components of trauma colors independent from the color of a healthy skin.The image recognition is used in the systems with artificial intelligence. It is possible to apply this knowledge for the creating a method for evaluation of the trauma age.

Key words: *bruise, color change in bruises, graph description, computer applying investigation.*

INTRODUCTION

An injury or a wound is the damage to the body caused by the application of force (violence) to the body. They occur when the force is greater than the body's ability to absorb such a force safely. All wounds are important, however apparently insignificant. The most happen injuries are mechanical. They are very different but a big group is these, which are result of the blunt force. The blunt impact injuries are caused by blunt, non-penetrating force and there are three kinds: bruises, abrasions and lacerations [13, 14, 20, 21]. They may demonstrate the type of weapon, the time, the direction and the intent at the time of the assault, the relative positions of the victim and assailant. A contusion or bruise is a blunt force injury to the soft tissue, or more rarely to a bone when the skin is not ruptured. They are in connection with an extravasation of the blood into the subcutaneous or deeper soft tissues, as a result of some blunt impact of sufficient force to rupture blood vessels, usually capillaries. A rapid accumulation of blood may provoke a hematoma.

Usually about two weeks' period is required for healing of bruises under normal conditions. There are typical appearance and disappearance of different colors in process of healing. It is due to the process of hemoglobin degradation. Breakdown products of hemoglobin e.g. biliverdin and bilirubin process various colors of the bruise. On other hand the bruise color depends on many factors [7, 9, 12, 14, 15, 18, 17, 21]. Some of them are: the characterization of a hit - force (depth), area of the apply, direction and duration; the place of the trauma on the body; the biological and anatomical features of the patient -age, fullness, sex, disease, blood pressure, temperature of body, skin color and etc.

Determining the age of bruises is an important aspect of forensic medicine. It can have significant medico-legal consequences. Many forensic pathology books and papers have described how bruise color changes over time. The analysis is made visually of these kind traumas for alive human and it depends on a forensic physician experience. The changes of bruise colors suggest that the time interval will be approximately defined. The colorimetric measurements are the most common techniques used to assess the age of bruises on a victim's body too.

COLORS' FEATURES INVESTIGATION

It is made an examination of large number papers in this aria. In the work is proposed the summary set of bruise colors. This is a graph description with marking knots for the different colors and arcs pointing to the sequences of the trauma colors, changing according to the experts. The time is indicated on the left side of graph. It is obviously, that the description of the time intervals between the trauma colors is fuzzy - "may appear", "till the first day", "possible to appear" etc. This graph is showed on fig.1. Different branches

are applied to show variety experience of the physician. It is possible to make a conclusion for each bruise color:

- *Red color*

This color [7] is characteristic for bruises of all ages. It may appear after first hour of the contusion. Other authors [1, 3, 5, 10, 16, 15, 19] pointed the red color on the first day of contusion, namely 0-24 hours. In [2] the red color can be seen for the bruises of age less 48 hours. According to [6, 8, 9, 20] the red color appears on the first two days after contusion. Red color [12] appears on the first day still, and it is presented on some of next days (like 2, 3, 6, 7, 9 days). This color [17, 18] is visible on first 5-7 days, but according to [11] this color may appear always in period from contusion to full resolution.

- *Dusky red, dark purple color*

The dark purple color appears in the contusion period till the third day [19] but the purple color [12] is present on 2, 8,10th day after the injury. The same color in [6] is visible at time interval 2-5 days, but in [8] is pointed that the purple red color is possible to appear after 2-5 days.

- *Pink color*

The pink color is visible on the first day [12].

- *Violet color*

The violet color is present at the beginning [4, 13].

- *Blue color*

In the first twenty-four-hour is present the light blue [19] or after 11 days [12]. The blue color is possible to appear at one time or another after the contusion [7], for the time less than 48 hours and in injuries after 7 days [2]. The other authors made the conclusion that the same color is presented in the interval of 2-5th day [8], after the third day of the contusion [5] or is presented on the 2,3,4th day [12]. The dusky blue is present till the third day [1,4]. The other authors point the 20th day [18] or at one time or another after the injury [11].

The dusky blue color is present in the time interval 1-3 days [13].

- *Green color*

It is very difficult to recognize the real green color because it is a mixture from blue and yellow colors according to [7]. The green color appears in the period of 2-5 days [6, 15, 20], 4-5 days [5,16], 4-7 days [3, 4, 10,1,19, 8], after 7 days, but it is possible to see the color in the time less than 48 hours [2]. After [12] the green color is present on the 1, 2, 3, 4, 8, 9, 10 and 11th day, but during the time interval 6-8th day the light blue color can be seen.

- *Yellow color*

The yellow color is not present in the time intervals 0-6 and 7- 18 hours [7, 18, 11] but it is possible or not to appear after 18 hours. After [16] the yellow color starts to appear in the interval 1-3 days, 4-7 or 7-10 day but after - 1-2 weeks (4-5 days, 1 week, 8-10 days, 14 days) as it is said in the paper [3, 4, 10]. The authors [1,19] make the conclusion that the bruise yellow color is after 4-7 days, after 7 days and for less 2 days [2], in the time intervals 7-10 days [8, 5, 14,6,13] and 7-12 days [15]. This color is visible after 40 hours and in the days 2, 3, 4, 5, 7 and 13th after contusion [12] and for the age bruises 2, 3, 4, 7, 8, 9, 11, 12 days [17,18]. The authors of the paper [9] consider that if this color appears the bruise age is more then 2 days.

- *Brown color*

According [1] the brown color can see after 1-3 days, 8-10 days [19], 1-14 days [6,8] or for the bruise age more than 7 days and less then 2 days [2]. The other interval is shown in [12] - 1, 2, 4, 5, 6, 9, 10, 11, 12 days after the injury.

- *Resolution*

The time of full resolution is at least 2 weeks [1, 3, 4, 5, 10, 13, 16, 19], but it is possible to be longer 2-4 weeks [6,8] or 1-4 weeks after [14].

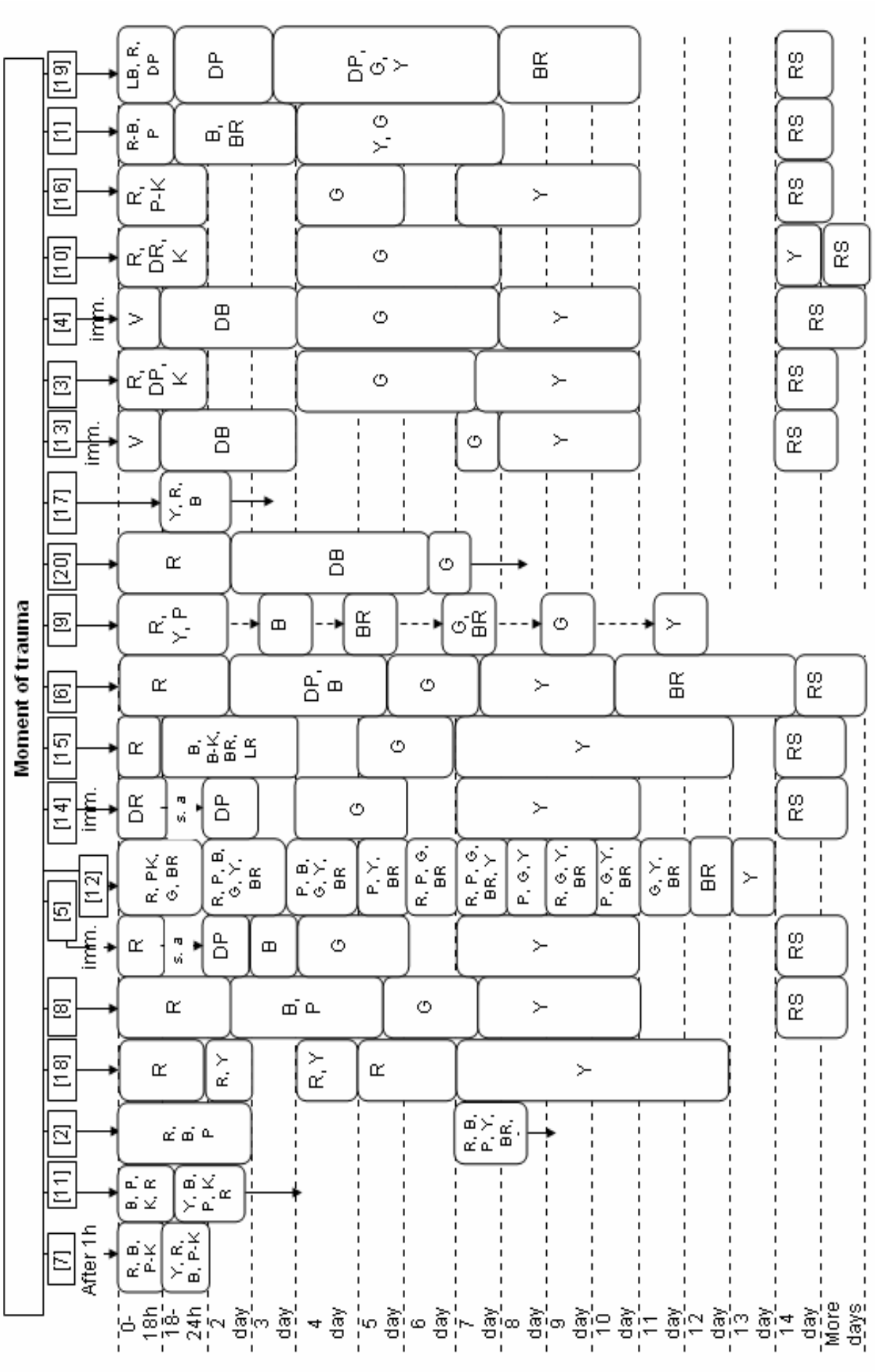

Fig.1. The graph description of the bruise color changes over the time

The applied curtailments in the graph description are: B - Blue; B-K - Bluish-Black; B-K - Bluish-Black; BR - Brown; DB - Dark Blue; DP - Dusky (Dark) Purple; DR - Dark Red; G - Green; K - Black; LR - livid red; LB - light blue;P-K - Purple-Black; PK - Pink; R - Red; R-B - Red-Blue; RS - Resolution; V - Violet; Y – Yellow; imm – immediate; s. a - soon after.

It is very important to receive the colors of bruises from the digital pictures. The appropriate software has been developed for an analysis of bruise colors [21]. It is taken into consideration that the human skin has not homogeneous color, the surface is not even and it is very difficult to get the picture without shades. The skin is a kind of a texture for which can be received a description like auto-correlation, Fourier transform in small windows, wavelets or filter banks, feature vectors, statistical descriptors, Markov chains etc. The segmentation can be done like textures - dividing the image into regions with approximately uniform color. The software works with standard bmp-files and separates the bruise from the rest skin picture. It is possible to see the visualization result in a window, select rectangular parts from the image and receive statistical values for the RGB-component of the color.

In the table 1 is shown the statistical result of the image processing for the not damage skin segments on the different part of the human body. The number of segments is 110.

Table 1

	The differences between the average and the most frequently found values of the RGB components for the not damage skin segments for variety human body's parts *max[freq-average]*					
	R		**G**		**B**	
	-	**+**	**-**	**+**	**-**	**+**
Body	-2	3	-1	2	-3	4
Legs	-2	2	-3	3	-3	2
Face	-3	3	-5	6	-5	7
Hands	-1	3	-3	3	-4	4

The maximum of the differences is for the red color - 6, green color - 11 and blue - 12. These values are in the diapason of the human recognizing of the image colors. The investigation has been made by using the average value and the most frequently found RGB values. The better results have been received by the second values.

A statistical investigation has been made to get RBG–components for variety of trauma colors. For this purpose is applied the same computer software which has possibilities to calculate components of trauma colors, independent from the color of a healthy skin [21]. The bruise' segments on the different body's parts have been taken. The number of bruise's segments was for the various bruise colors as follows: yellow and violet color - 85; red color - 55; green - 50 and blue - 35. The table 2 shows the results. The number of each RGB-component is 0 to 255 between.

There is a relationship between the RGB-components for each bruise color. The max values give light color and the min - dark. It is possible to see how much is the influence over the color change if modify RGB-values pointed in table 2 borders.

Table2

Color	statistical	number	Min values			Max values		
			RED	GREEN	BLUE	RED	GREEN	BLUE
yellow	freq	85	156	115	74	230	216	177
	aver	85	155	113	74	227	211	174
red	freq	55	125	37	39	236	163	160
	aver	55	136	47	47	238	161	155
green	freq	50	102	104	103	181	198	197
	aver	50	99	102	106	180	197	193
blue	freq	35	72	86	97	176	191	211
	aver	35	75	88	97	178	188	207
violet	freq	85	132	129	155	255	230	255
	aver	85	134	135	154	253	232	250

The violet color saves by B=155 if G=129 and R is from 132 to 210 or by R=132 and G is 90 and 140 between. The investigation of the blue color points that the color is preserved by B=97 if R=72 and G - from 86 to 100 and if G great 100 the color becomes green or G=86 and R from 72 to 90, after 100 - violet. The green color becomes violet one when R great than 100 by G=104 and B=103. The red color changes from dusky red by R=125, B=39, G=37 - 60 to brown by 90 and then dark green.

It is possible to receive a mathematical model of this relations but it is not the purpose of this work. On the other hand it is very interesting to connect these models with the quantity of blood components by hemoglobin degradation.

CONCLUSIONS AND FUTURE WORK

The investigation of the bruises color has led the conclusions:

- It is possible to recognize the bruise aria and not damage human skin on the same part of body applying software for separating by color;
- The color change in bruise has descriptions with variety colors and time sequences depending on the experts' experience. They use fuzzy terms for the defining a moment of color change;
- It is quite possible to make a statistical investigation and receive RGB-components of the each color in bruise. The color relationship may be point in the borders which are specific for a human skin. The RGB-components of the bruise colors are subset of the set of true color graphics systems used in the digital images;
- The most suitable statistic characteristic is the frequently found values of the RGB-components.

The future investigations are in the field segmentation of the bruise image according to the different colors and to define their area and the bruise age.

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