

## RGB and HSV colour models in colour identification of digital traumas images

Lidiya Georgieva, Tatyana Dimitrova, Nicola Angelov

**Abstract:** Estimating the age of bruise is a problem frequently faced by a practicing medical expert. Estimation of the bruise age is based on determination of colour. Visual determination of colours is subjective method. In this paper recognition with computer software is proposed. There are examined RGB and HSV colour models for trauma's images taken by digital cameras. Examination on hue values range for original and processed images of traumas is shown. This is helpful for determination of trauma colours.

**Key words:** Colour models, RGB, HSV, traumas, contusion, age of bruise, digital images.

### INTRODUCTION

The estimation of bruise age is a problem frequently faced by a practicing medical expert. The examination shows that there are many difficulties for accurate estimation of bruises' age. This type of blunt traumas is one of most frequently met traumas. It can result from a moving object striking a stationary person, stationary object or surface striking a moving person and moving object striking a moving person. Many of the injuries are a result of automobile accidents, falls and others [4].

The bruise as a rule is simple injury. It is "a haemorrhage into tissues produced by the escape of blood from blood vessels". Bruises may be found in different places - skin, muscles, and internal organs. A simple bruise of the skin, isn't associated with any other type of wound. It is "a haemorrhage beneath the skin producing discolouration without any associated break on a skin surface"[5]. The most common types of bruise are skin bruise (fig.1a) and muscle (intramuscular) bruise (fig.1b) [7].

The blood is collected under the skin due to the tearing of the blood vessels and after that is gradually absorbed. Some colour changes are seen during of absorption process. The blood changes morphologically and biologically. The blood consists of red blood cells which have the matter haemoglobin (Oxygen carrying red pigment of the red blood cells). Due to the injury, these red blood cells disintegrate and the haemoglobin is influenced by enzyme (An organic compound capable of producing a specific action). This produces the colour changes in the bruise and gives an indication for the bruise age. The colour changes begin first at the periphery and later extend to the centre [5].

A fresh bruise has reddish colour because blood contains oxyhaemoglobin (OxyHb) and haemoglobin. The brawn colour is due to methaemoglobin, green – biliverdin, yellow – bilirubin.

There are many scientists where investigators are trying to determinate accurate way to estimation of bruise age. Usually the estimation is made by forensic medical expert with rich experience.

There are some basic ways for estimation colours and age of bruises. The most frequent way is visual, and is based on expert's experience. This is very subjective method, because everything depends on knowledge and experience. The second way is estimation with applying a colour table from person without experience. This method is subjective too. From fig.2 it can be seen that sensitivity of different people varies, therefore colour determined by volunteers will be different.

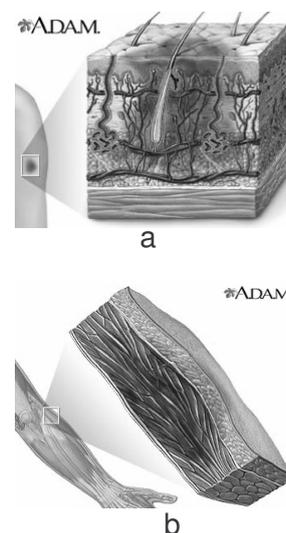


Fig.1 Bruises  
a) Skin bruise;  
b) Muscle bruise

Ultraviolet photographs are used in forensic practice too, but it is used only as a proof for presence of traumas. With such photographs may give evidence that a person had contusion, but can not define when this contusion has happened.

Comparatively new ways are based on the use of a spectrophotometer or digital camera.

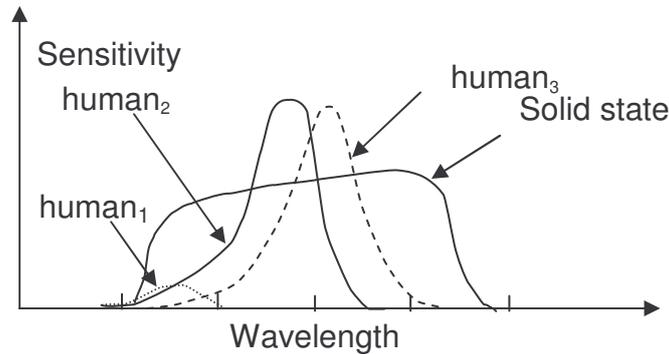


Fig.2. Sensitivity of some persons

The priority of using digital camera is a possibility for computer image processing. A most objective estimation of colours can be made with the help of a computer and software products. Many different colour models exist in computer graphics. Each model uses 3D coordinate system to identify uniquely individual colours. In this work two colour models are chosen - RGB and HSV colour models.

**WORK WITH COLOUR MODELS**

When talking about colours, we have to keep in mind that colour can be realized in different ways. The colour models are based on a physical, physiological and technical aspect [3].

➤ **RGB (Red, Green, Blue) colour model (Fig.3)**

To see how a RGB model works, we first have to look at the technical aspect of colour. The human eye perceives colour reaction through a mix of red, green and blue signals. It was a thought that each colour can be mixed with only these three primary colours.

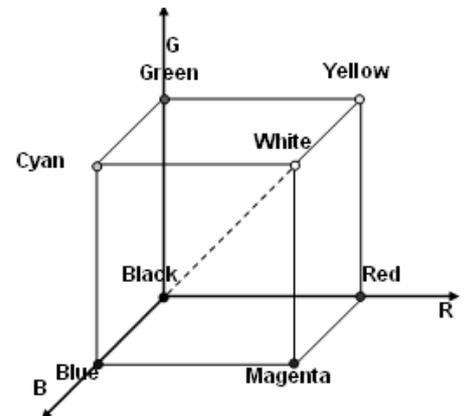


Fig.3. RGB colour model

➤ **HSV (Hue, Saturation, Value) colour model (Fig.4)**

The HSV colour model, also called HSB (Hue, Saturation, Brightness), defines a colour space in terms of three constituent components:

- Hue is the colour type (such as red, magenta, blue, cyan, green or yellow). Hue ranges from 0-360 deg.
- Saturation refers to the intensity of specific hue. Saturation ranges are from 0 to 100%. In this work saturation is presenting in range 0-255.
- Value refers to the brightness of the colour.

Saturation ranges are from 0 to 100%. Value ranges are from 0-100%. In this work saturation and value are presenting in range 0-255.

**A typical image of the bruise**

It is possible to see a typical view of the bruise on the fig.5 and recognize some colours - red, yellow, green and violet.

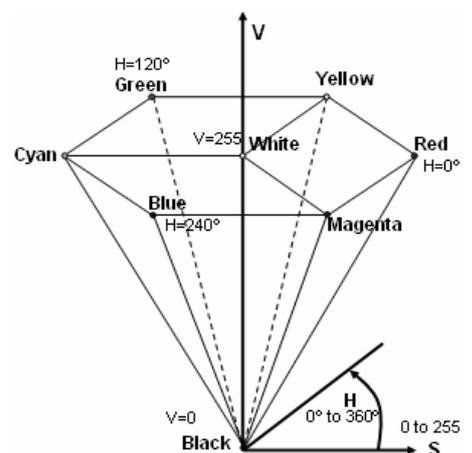


Fig.4. HSV colour model

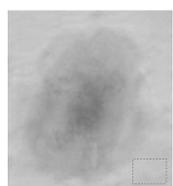


Fig.5. Original in - V.12-2 - . Processed image

The image is processed and the result is shown on fig.6. Processing include follow steps. First the operator has chosen a rectangular area near the bruise. The area was without changing of natural colour of the skin. After that the area is analyzed for determining the often met values of the tree components - red, green and blue for the healthy skin. The next step of this processing procedure is the extraction from the colour of pixels in the image the often met RGB components.

The 3D models of the distribution of all components' values of each pixel in the two images - original and processed can be seen in fig.7.

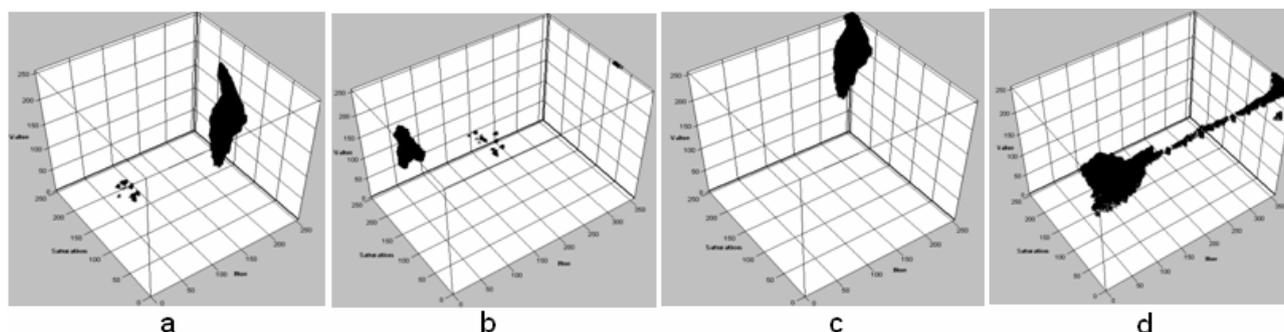


Fig.7. 3D models - RGB and HSV for the colour distribution for the two images  
a) original image in RGB; b) original image in HSV; c) processed image in RGB;  
d) processed image in HSV

The following conclusions can be made for the graphs in fig.7:

- The RGB model is difficult for defining a diapason in which the colour values make changes especially for the shade of concrete colour. The receiver set is situated on the cube diagonal (fig.7a, c);
- The HSV model gives a set, in which the boundaries for the hue component can easily be defined;
- In the original image (fig.5) some colours are visible - red, green, yellow and violet. If we present the values of the particular RGB components in the 3D graph (fig.7a) it is difficult to recognize colours in the image using only this graph. After the real image processing from RGB in HSV model the new graph (fig.7b) shows a presence only of red areas - the set has hue in the interval 0-50. It is the reddish colour in HSV hexagone;
- After the processing of the original image the result (fig.6) clearly shows different colours. The applying of the RGB model made the same troubles. The image converted in HSV model allows settling the other colours besides the red. Hue has values out of the red diapason in the HVS hexagone.

#### **Separate different colour segments from digital images of traumas**

The colour recognition of the bruise and its surrounding in the moment of evaluation has very important meaning for correct bruise aging. It is difficult to define real presence of clear colours and these which are received by mixture of some of them. The concept for the particular colour of different persons varies. Therefore defining of separate trauma colours by one objective evaluator (which is exactly personal computer) is useful in investigations of determination of the traumas age.

The colours, according to expert opinion in separate papers (research definition of bruise age), which appear from the moment of trauma receiving to full recovery are - red, blue, green, yellow and violet. There were made analysis of large number of digital images of this type of trauma. From them there were cut 25 areas, which present different shades of each colour mentioned above. These areas were processed by extraction from the colour of pixels in the image of often met RGB components for healthy skin. The original and processed images were present in HSV colour model.

As it is known, in this model hue is the attribute that corresponds to the object's red, orange, yellow, green, blue or violet. This attribute is often related to the hue circle, which has been recognized by artist, colour technologist, and decorators for years [1]. Exactly therefore there were made analysis of value of this component from HSV colour model. The results are show in diagram (Fig.7) for each colour.

- **Red colour** - is one of the most frequent colour in traumas. There are cute 25 segments, which are defined as reddish colour. On the next figure (Fig.8) the distribution of hue values for original reddish areas is shown (fig.8a) and for processed areas (fig.8b).

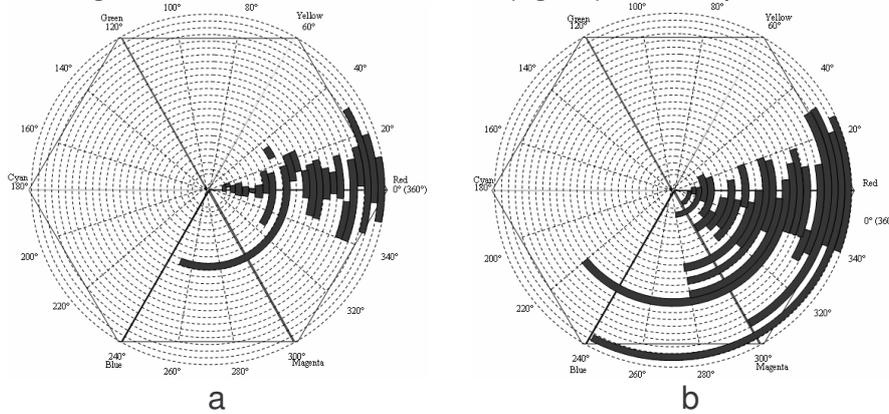


Fig.8 Hue distribution for reddish segments: a) original image; b) processed image

- **Yellow colour** – according to more publications this colour is most significant for the determination of bruise age. It is known that this colour is present in trauma, which has more than 18 hours of age, but the opposite is not true. That is to say that in trauma, which are more than 18 hours of age this colour may be present, but it may also not.

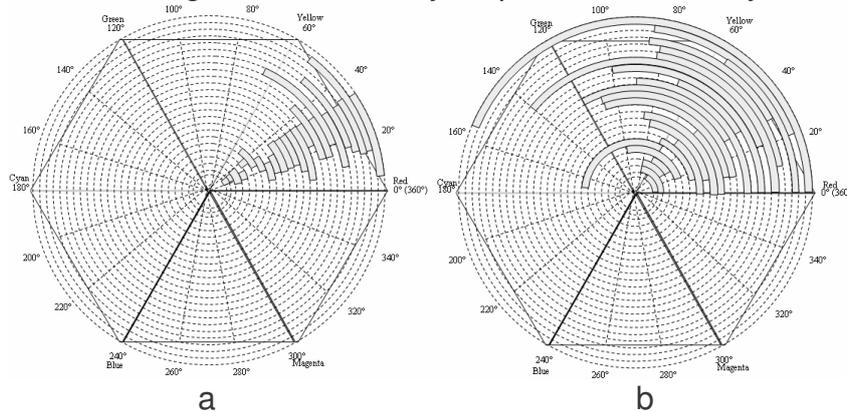


Fig.9 Hue distribution for willowish segments: a) original image; b) processed image

- **Green colour** – it is very difficult to differentiate whether this is clearly green colour or mixture from yellow and blue.

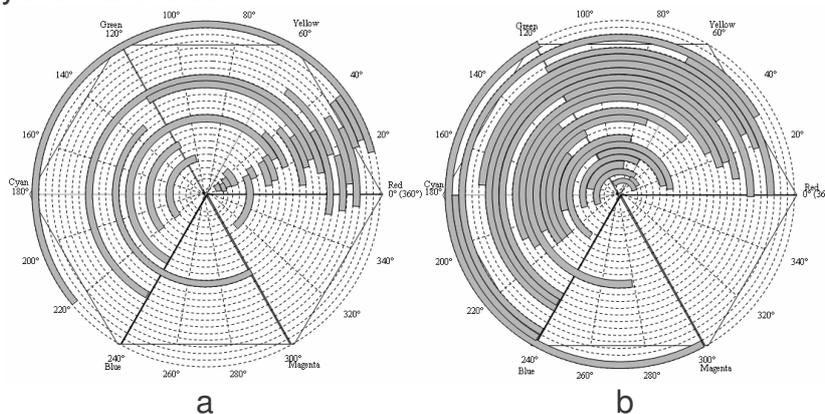


Fig.10 Hue distribution for greenish segments: a) original image; b) processed image

- **Blue colour**

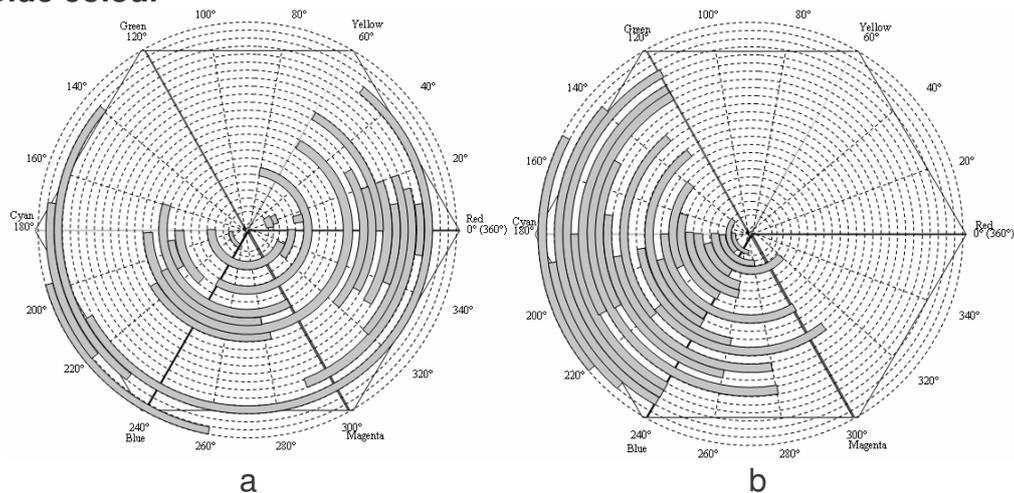


Fig.11 Hue distribution for bluish segments: a) original image; b) processed image

- **Violet colour**

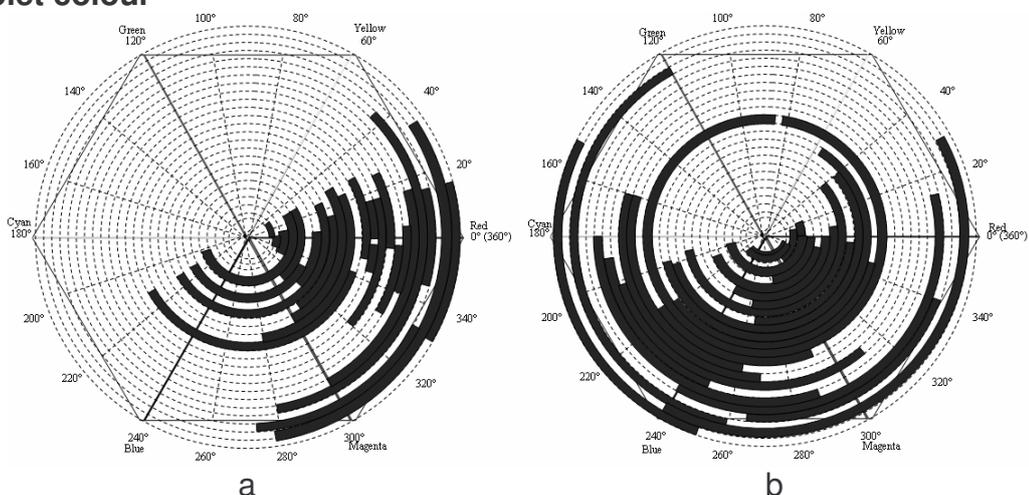


Fig.12 Hue distribution for violet segments: a) original image; b) processed image

**Discussion of achieved results**

According to the research in this work the following conclusions can be made:

➤ **red colour:**

Working with original digital images hue takes values from reddish diapason (30-340). On the other hand the same reddish areas after their processing the diapason of hue values is already more large (20-300), which present regions for red and magenta colours.

➤ **yellow colour:**

Working with original digital images hue takes values approximately in the diapason from 10 to 45, which corresponds to orange colour. Besides the same yellowish areas after their processing the diapason of hue values is already larger and corresponds to the diapason from red to green colour – where different shade of yellow colour can be exactly met.

➤ **green colour:**

Working with original digital images hue takes values approximately in diapason from 0 to 240, which corresponds to red, yellow, green, cyan and blue colours. Besides the same greenish areas after their processing the diapason of hue values is already 20-220 and corresponds to the diapason from orange to cyan-blue colour – where different shade of green colour can be exactly met.

➤ **blue colour:**

Despite the fact that the areas before extracting shows as bluish, after processing they do not show as so bluish because they are surrounded by healthy coloured skin. For this reason the value of Hue almost varies in the whole diapason of ranges (0-360°) which includes all kind of colours – Fig.11. Only in the interval from 60 to 140° (where the colours green-cyan, green and green-yellow are situated) hue does not receive values. Working with the same bluish areas after their processing, the diapason of hue value is already more limited (120-320). The centre of the blue regions is exactly in the colours circle. The widening of this diapason to the areas of green and magenta colours is more probably due to the troubles of separating the blue-green colour from the blue-violet colour.

➤ violet colour:

Working with original digital images hue takes values approximately in diapason from 0 to 30 and from 260 to 360, which corresponds to yellow, red, magenta and blue colours. Beside that the same violetish areas after their processing the diapason of hue values is already approximately from 0 to 20 and from 180 to 360 and corresponds to the diapason from red, magenta, blue, cyan colours – where different shade of violet's colour can be exactly met.

### **CONCLUSIONS AND FUTURE WORK**

As a result from the investigation we can make the conclusions that the image processing with extracting the often met values of the colour components is useful for determination of trauma colours and farther segmentation of colours in the different digital trauma images. The use of RGB colour model let to difficult definition of the boundaries of set of values for the variety shade of concrete colour. HSV colour model is useful for the definition of existing trauma colours.

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### **ABOUT THE AUTHORS**

Assoc.Prof. Lidia Georgieva, PhD, Department of Computer Systems, University of Rousse, Phone: +359 82 888 380, e-mail: [lgeorgieva@ecs.ru.acad.bg](mailto:lgeorgieva@ecs.ru.acad.bg).

Tatyana Velikova Dimitrova PhD student, Department of Computer Systems, University of Rousse, e-mail: [tdimitrova@ecs.ru.acad.bg](mailto:tdimitrova@ecs.ru.acad.bg)

Assoc.Prof. Nicola Angelov, Department of Automatics, Information and Control Techniques, University of Rousse, Phone: +359 82 888 678, e-mail: [Angelof@ru.acad.bg](mailto:Angelof@ru.acad.bg)