



APPLICATION OF IMAGES SEGMENTATION FOR EVALUATION STRUCTURE OF WHITE BRINED CHEESE

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INTRODUCTION

The process of images segmentation includes association of every pixel with a specific group of pixels i.e. every pixel has to be grouped with other pixels according to its color and/or its relation with neighbours. The result of the segmentation is an image with foreground (objects) and background areas. The segmented image emphasizes objects on the image, thus the image segmentation is a very important step in process of automatic object recognition.

INTRODUCTION

The image segmentation algorithms use different techniques such as region growing, edge detection, thresholding and etc. The algorithms for images segmentation are widely used for food quality evaluation and especially for cheese quality analysis. The aim of current research is to propose fast and effective approach for a structure evaluation of white cheese in brine using images segmentation in HSI (Hue, Saturation, Intensity) color space.

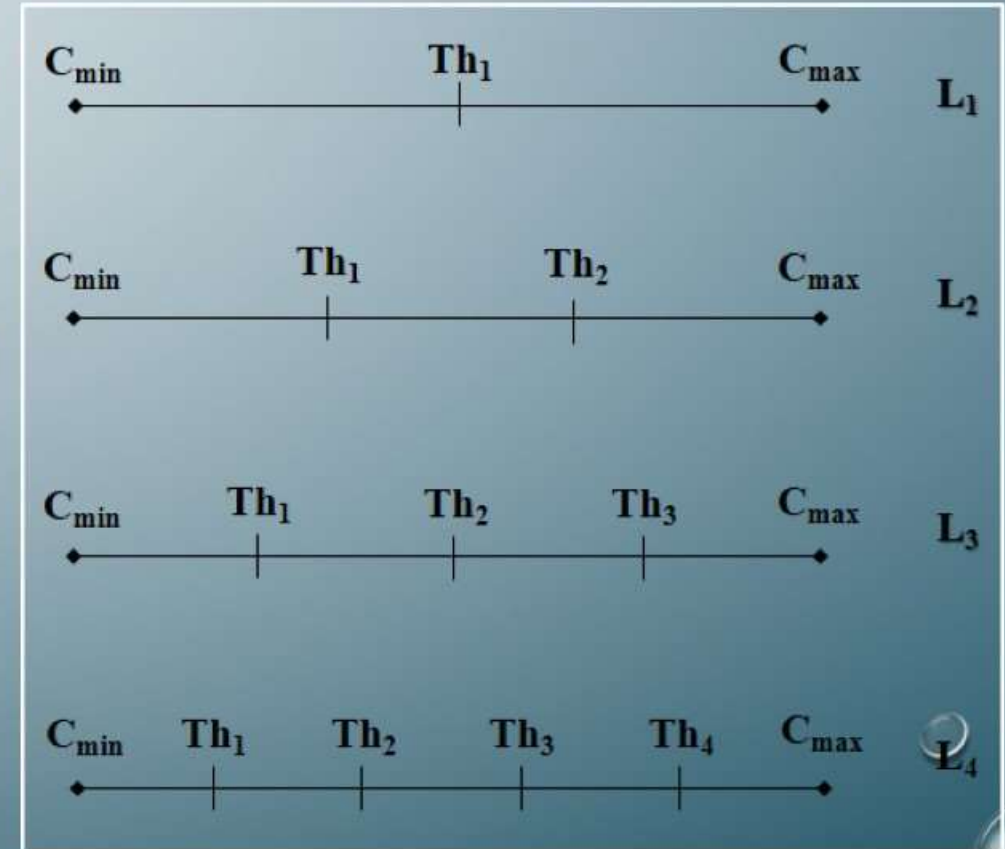
MATERIALS AND METHODS

It is developed a Java application for images segmentation using HSI color space. This color space is appropriate for images processing of white brined cheese because the quality of cheese structure depends on small differences in color intensity. Multiple thresholds for HSI components are used for images segmentation. Number of colors in segmented image depends on the level of segmentation (L_s). For the first level of segmentation there are used two colors i.e. the result of processing is a binary image. Every next level of segmentation uses one color more in comparison with the previous level of segmentation according to next formula:

$$Colors(L_s^i) = Colors(L_s^{i-1}) + 1$$

MATERIALS AND METHODS

The thresholds for HSI components are medians for every level (according to figure). The minimum and the maximum value for every HSI component in current image are noted with C_{\min} and C_{\max} . It is used three additional arrays for every HSI component and these arrays are sorted in order to identify medians. Number of thresholds depends on level of segmentation. For first level of segmentation there is only one threshold value (Th_1). The last level of segmentation (L_4) defines four threshold values (Th_1 , Th_2 , Th_3 and Th_4).



MATERIALS AND METHODS

The color (C_i) of every pixel in output segmented image (p_{out}) is defined by formulae:

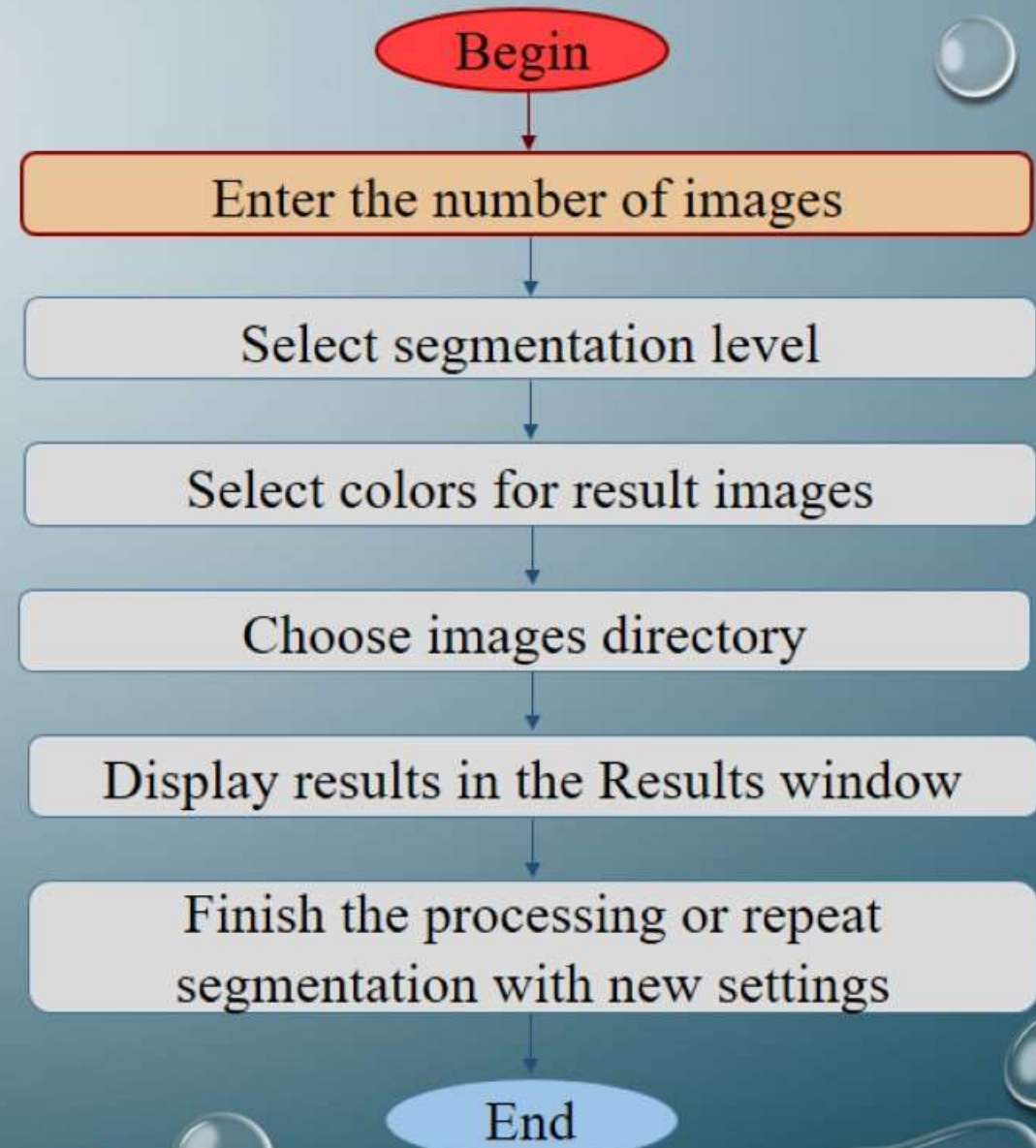
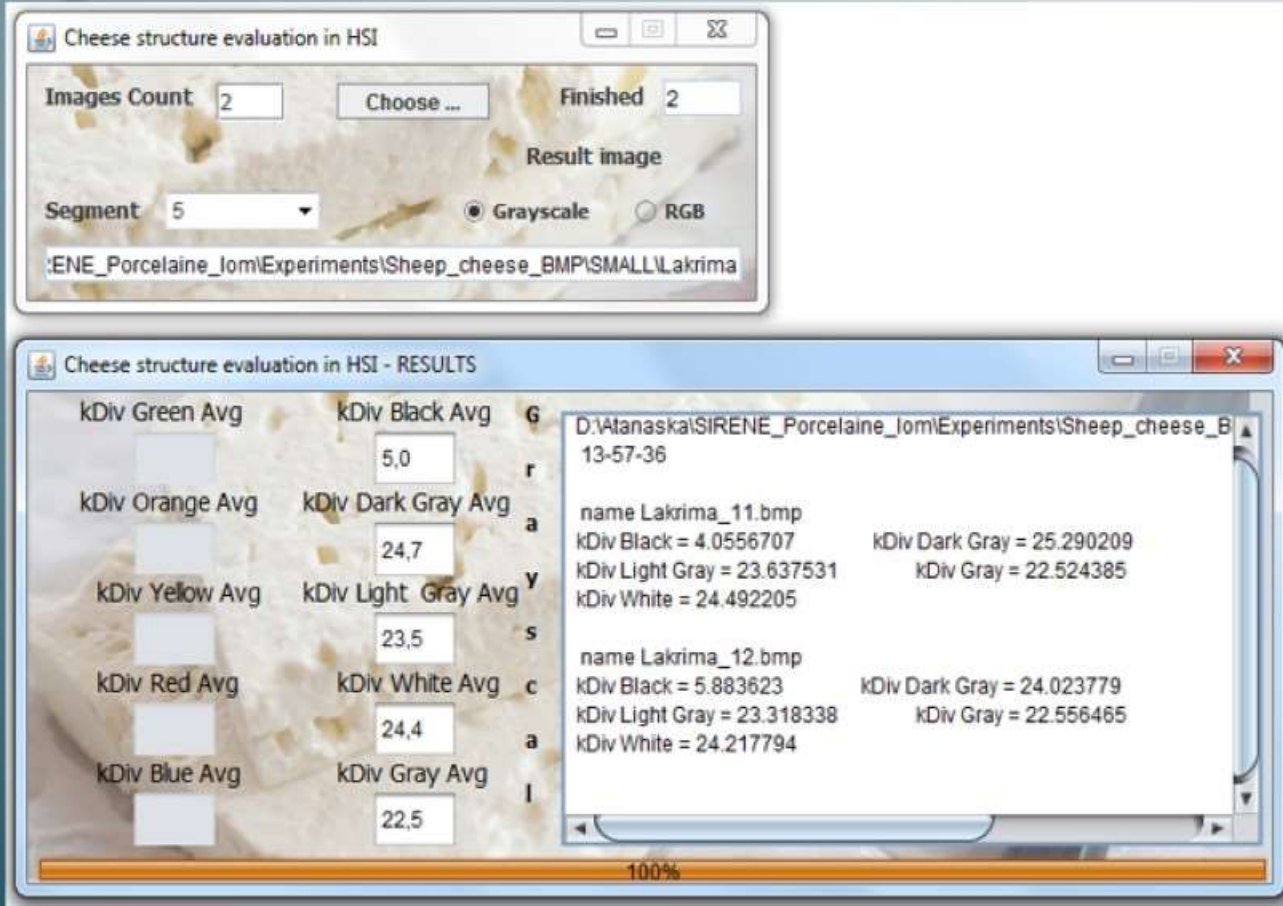
$$p_{out} = \begin{cases} C_1, p_{in} < Th_1 \\ C_2, p_{in} \geq Th_1 \end{cases}$$

$$p_{out} = \begin{cases} C_1, p_{in} < Th_1 \\ C_2, Th_2 > p_{in} \geq Th_1 \\ C_3, p_{in} \geq Th_2 \end{cases}$$

$$p_{out} = \begin{cases} C_1, p_{in} < Th_1 \\ C_2, Th_2 > p_{in} \geq Th_1 \\ C_3, Th_3 > p_{in} \geq Th_2 \\ C_4, p_{in} \geq Th_3 \end{cases}$$

$$p_{out} = \begin{cases} C_1, p_{in} < Th_1 \\ C_2, Th_2 > p_{in} \geq Th_1 \\ C_3, Th_3 > p_{in} \geq Th_2 \\ C_4, Th_4 > p_{in} \geq Th_3 \\ C_5, p_{in} \geq Th_4 \end{cases}$$

MATERIALS AND METHODS



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According to standard BNS 15612-83 quality and structure of cut surface of white cheese in brine depends on quantity of bacterial holes, smoothness of the surface, presence of porcelain structures on the broken surface and etc. The term “porcelanov lom” is used by Bulgarian standard in order to define appearance of visually presented structures on the broken surface. These structures look as surface of broken porcelain bowl and they have to occupy more than 80% of the broken surface if the cheese has high quality.

RESULTS AND DISCUSSION

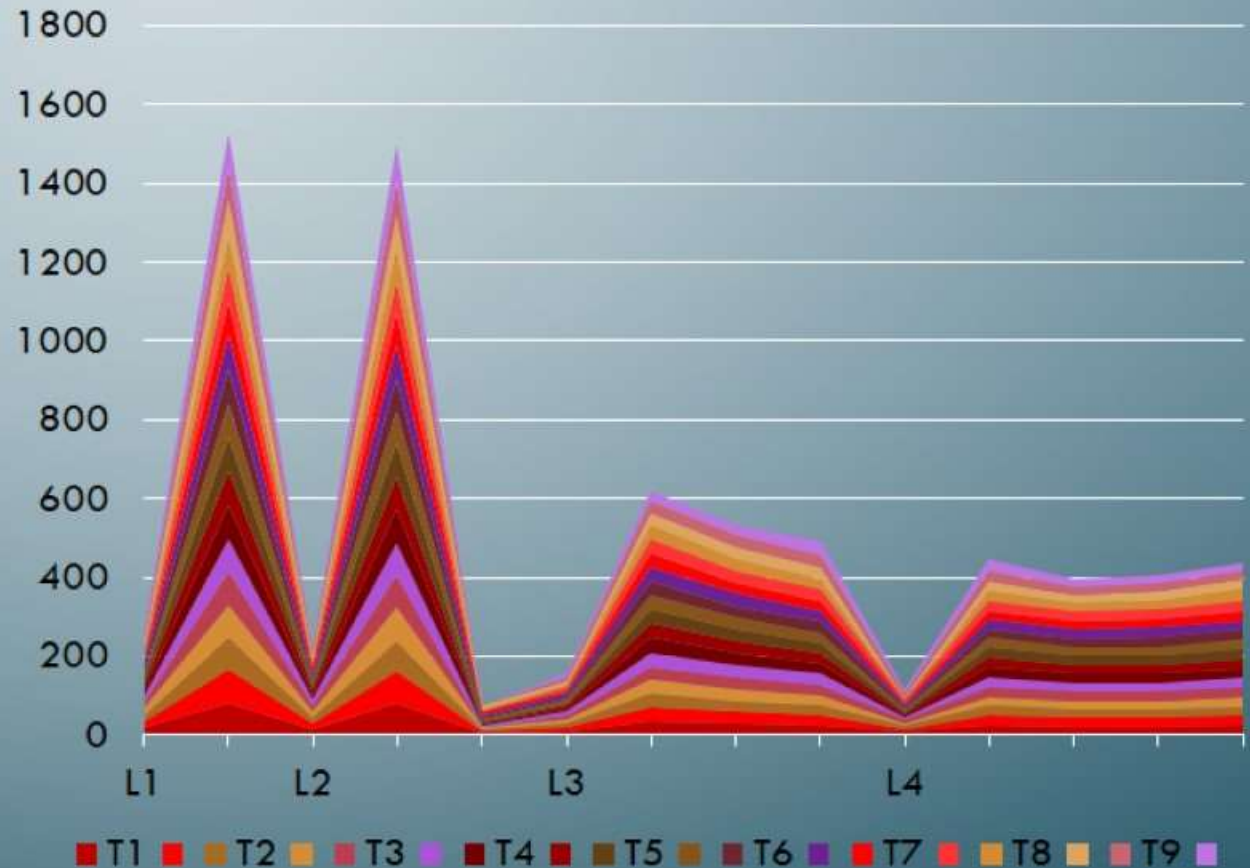


The sample of cheese of T8 has smooth cut surface with small number of technical holes (with small size) and well defined porcelain structures on the broken surface. The sample of cheese of T7 has uneven smooth cut surface with big technical holes and broken surface without porcelain structures.

	Images of trademark T8		Images of trademark T7
Original		Original	
Segmented- L ₁		Segmented- L ₁	
Segmented- L ₂		Segmented- L ₂	
Segmented- L ₃		Segmented- L ₃	
Segmented- L ₄		Segmented- L ₄	

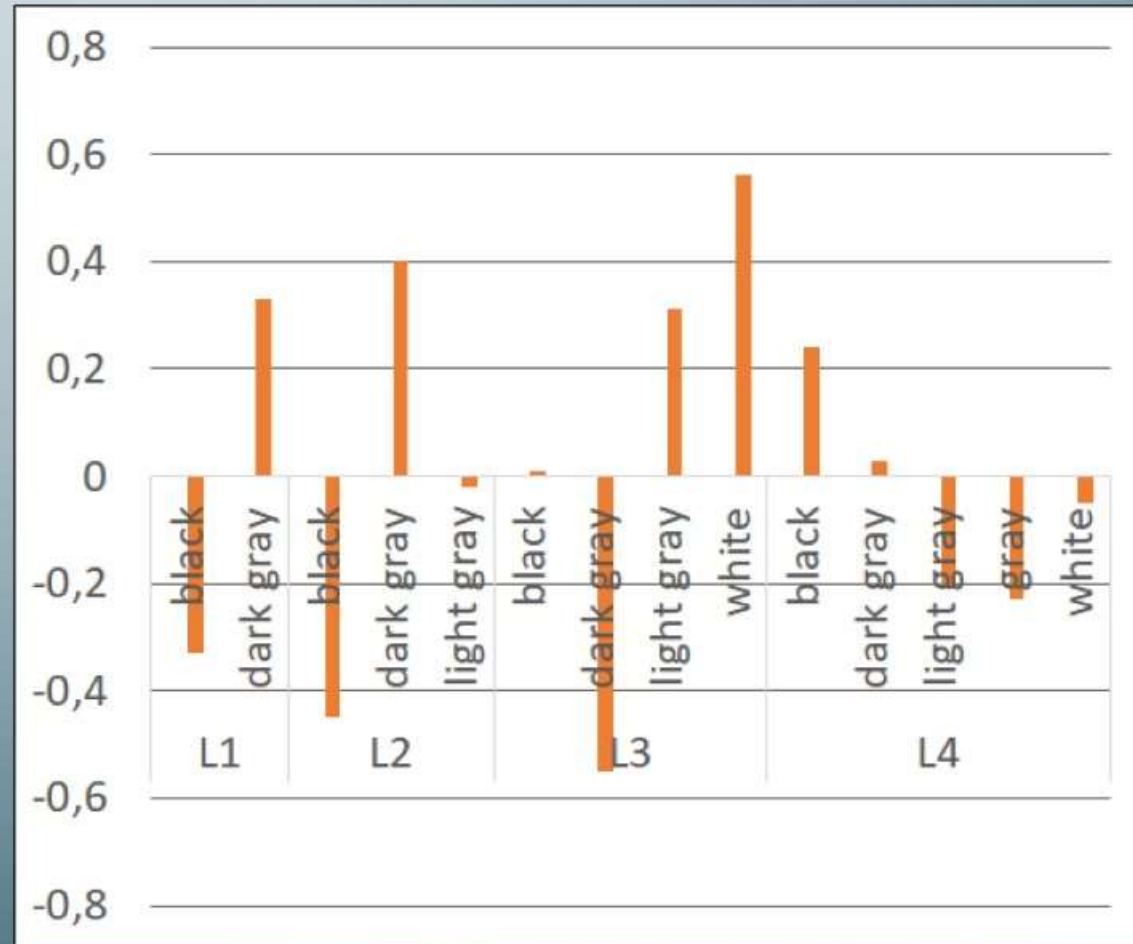
RESULTS AND DISCUSSION

The figure presents K_{div} (coefficient of diversity- ratio of pixels with the same color to all pixels in segmented image) for every color for the examined samples of cheese and for all segmentation levels.



RESULTS AND DISCUSSION

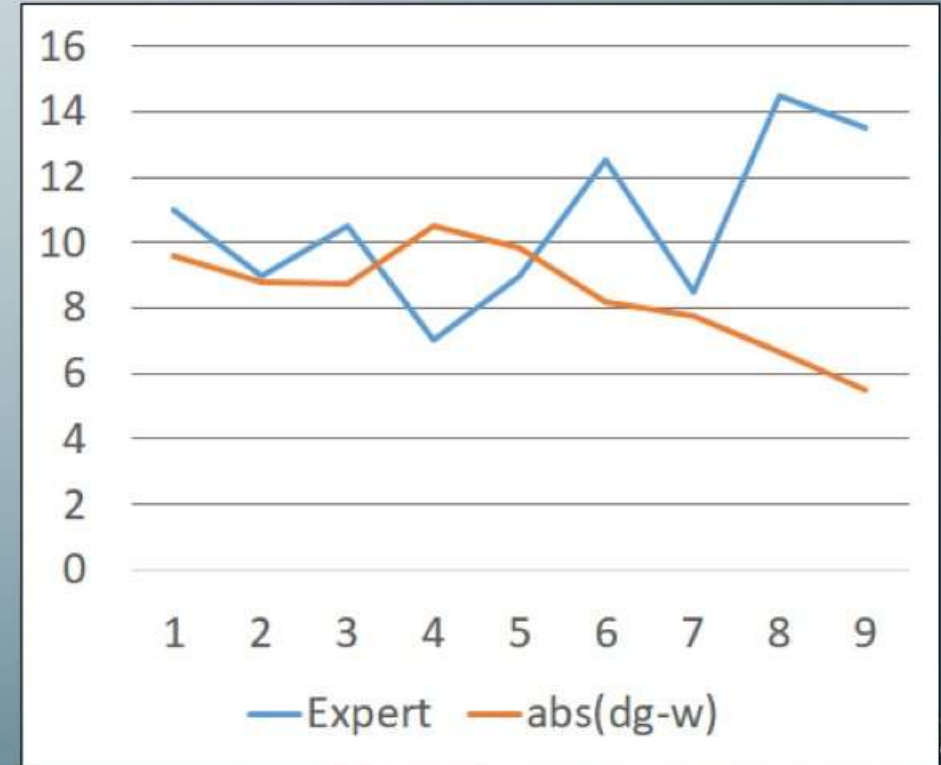
The figure presents correlation coefficients calculated using functions of MS Excel. These coefficients are calculated for expert evaluation versus Kdiv of every color for all levels of segmentation.



RESULTS AND DISCUSSION

It is observed that the highest correlation coefficients are calculated for level of segmentation L_3 for dark gray color and white color. The figure presents the expert evaluation and the absolute value of difference of K_{div} for dark gray color and for white color.

Trends of functions show that they have significant negative correlation (correlation coefficient is about -0.77).



CONCLUSION

Samples of nine trademarks white sheep cheese in brine are used for evaluation of cut surface quality and structure. The results could be summarized as follows:

- the level of segmentation L_3 uses four colors for segmentation and this processing emphasizes on specific areas in cheese structure in the result images;
- pixels with dark gray color and with white color both give a significant information about cheese structure quality;

CONCLUSION

- the proposed approach for images segmentation in HSI color space could be applied to support the experts work for white cheese structure quality evaluation.

The study will continue with researches over possibilities for accurate analysis of cheese structure using complex evaluation of cut surface and broken surface of the cheese, through their images processing.

THANK YOU FOR YOUR ATTENTION !!!

Please, use e-mail for questions and discussion:
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