A Method for Colorization of the Original Grayscale Tesla Photograph

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Abstract – **The method for picture colorization of one the Nikola Tesla's original photograph will be explained in this paper. The aim of this paper is to enliven patents which may contribute to enlarge information related to scientific knowledge. This project presents a simple method which requires precise picture colorization and its possible animation. The colorization method is based on a simple assumption of opposite pixels in space and good understanding of the period when the picture is made.**

Keywords – **Image processing, grayscale image colorization,**

I. INTRODUCTION

There is a great need for the enlivening of the picture as well as for the restoration of the picture until their movement is archived. There is more often need for the use of pictures from the distant past which are in relation to the key words for revealing details on which certain sciences are based: medicine, information technology, electrotechnics etc. One of the ways of enlivening pictures is picture colorization. Picture colorization is one of the key answers to a wide spectre of digital processing of monochrome pictures. In that way picture is enlivened and it shows the past. These are some of the reasons for appearing of big interest for the further research, improvement and the use of method for picture colorization. Picture colorization means it is necessary to animate picture when the illusion of drawings movement is achieved, by the models or lifeless things. For an animation of pictures different methods are used, the most included method is the presentation of animation of moving pictures or video animation. Animation makes the pictures become very real and there is an impression of their current, real existence.

II. PICTURE COLORIZATION

Colorization is the method which is used for adding colours to black and white picture. In order to do the successful colorization method, it is essential to prepare basic picture stem. Base improvement is done by the method of picture restauration whose main aim is to refresh some parts of the picture, to remove rustle which very often appears because of the processing. Generally speaking, the process of picture improvement does not enriched the informative content of the picture nor is the originality of the pictures lost but it only makes easier the use of existing information in a particular picture. In order the present picture colorization in the best way we will take as an example the picture of Nikola Tesla, which is very specific and unique.

Fig 1: Nikola Tesla with his invention - original image (Nikola Tesla Museum of Belgrade).

Considering the fact that Nikola Tesla was in some way perfectionist during his life, it is a big challenge to do the colorization of his picture because it means to use the knowledge about Tesla's life. It was needed to know Tesla's habits and details of his life which means to know the life of Nikola Tesla and the start the work.

The picture, on which we will be working, is the original, which is kept from the distant past in the museum of Nikola Tesla in Belgrade (Fig. 1). Considering the fact that pictures used in the past can not be compared to the present ones, it makes this challenge greater to do the colorization of reality which was done in Grayscale technique.

As it can be seen Grayscale picture contains a great number of grey tones. In order to make the correct and exact picture colorization it is needed to define all pixels in the picture. The Gray picture is the one where every pixel represents a particular sample, which has only the information about intensity [1].

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This kind of picture is made of grey tones and they can vary from the one which has the weakest intensity (black) to the one with the strongest intensity (white). The intensity of pixels of grey picture is in the range from 0 to 255, where 0 is black and 255 is white, or from 0 to 1, where 0 represents black and 1 represents white, other numerical values represent different levels of grey (Fig. 2).

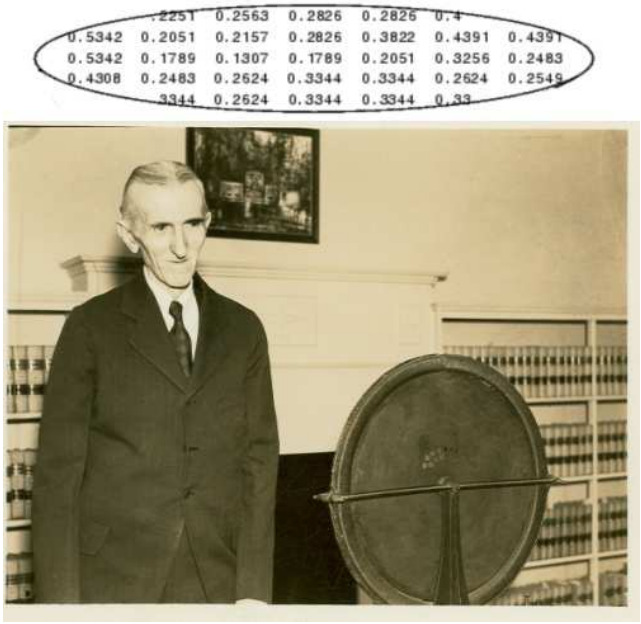

Fig. 2. Grey image in the range of 0 to 255.

Every pixel of grey can be expressed by formula (1):

$$W_{ij} = e \bullet \frac{\left\| F_i - F_j \right\|^2}{\sigma_I^2} \bullet \frac{\left\| X_i - X_j \right\|^2}{\sigma_X^2} \qquad (1)$$

Where is:

Fi – vector describing the characteristics most frequently pixel color

Xi- node pixels

Where the following condition (2) must be true:

$$\left\| X_i - X_j \right\| < r \qquad (2)$$

Where “i” represents special location of the pixel; While “F_i” vector describes characteristics of a pixel which are based on information related to intensity, color and texture and "r" is distances of pixels.

If this distance approaches 0 the more shades of white pixels harder. Since all the pixels are defined, it is needed to copy the color from the original patent in the most realistic way [7].

Now, the functions F_i is defined in a different way. It is based on the color used, expressed by the formula:

$$F_i = \left[v, v \cdot s \cdot \sin(h), v \cdot s \cdot \cos(h) \right]_i \qquad (3)$$

Where is:

v, s, h are the values of the color spectrum that is used for image segmentation

Important fact is that someone must subtracts function F_i and F_j between two pixels deducted all components then take into account all three components of value, which will be shown in Figure 4.

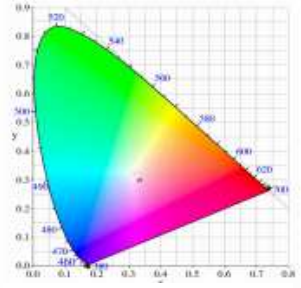

Fig 3: The color spectrum

Color [5] is related to a particular light feeling of physical quality of light, the movements of which can be noticed by a human eye (Fig. 3). Rays of light are electromagnetic movement of precisely defined wave lengths.

At different moments the human eye registers colours in different ways. The same goes for technics (cameras) which makes artificial light in order to save the color.

We can say that colours reflect in a different way from different points. In that way expression of colours in a picture can reduce the quality of picture. It is very important to give adequate colour to a definite grey.

By combination of grey tones and colorization we can make very effective and pleasant picture to our eye. In the process of colorization, after tidying of the basic picture, the separation of the edges and putting the colors are performed.

The edges represent local discontinuities of lightning (or colors) in the picture and they give a good indication of the borders of the objects in the scene [2],[6].

Fig. 4. The edge processing.

In Fig. 4, edges can be clearly seen and they should be carefully done (marked by yellow arrow) especially motor edges because the motors will be more noticeable throughout the animation. If it is not done carefully the process of

colorization animation will be quite unreal and unsuccessful because the effect of the real motor will not be achieved. All the elements should be separated and done individually in order to give qualities separately and not to lose the quality of the details of the picture.

Near the borders of the regions it is considered that measures of texture are changed from one valve to another. The same goes for the detection of edges of small slope so that degrees of operation can be used for segregation of edges and pressing of non maximum during the formation of maps of edges. In that occasion wavelet transformation is used and it presses colours on grey picture, and the result of this colorization [3],[4] is shown in Fig. 5.

The edge processing is very important especially for the region determining. Our approach is basically manual one, but we are exploring some other algorithms of the automatic image processing and region determining.

Automatic region determination is unchangeable when animation and movie processing is in focus. When we work only with single images, the manual approach is satisfied (Fig. 5).

III. Partial Picture Animation

Animation is the process of picture presentation on the computer screen which changes rapidly in a sequence. It can be made with hand-made drawings, with pictures generated by computer or three-dimensional objects or by the combination of these techniques. The position of each object in any picture is related to the position (place) of that following picture, so that objects can move indepedently one from the other without any troubles. Appliances for presenting show these pictures very fast, most frequently 24, 25 or 30 frames per second.

Colorization and animation are the methods which are used in the picture with Nikola Tesla and his motor patent (Fig. 6). This „hard“ picture wasn't chosen by accident, it was because it had very visible and difficult damages and beside that we wanted to move the motor which is in the picture.

However, with this project we managed to eliminate different damages, to do the colorization, to enliven motors and to move it by animation. It was needed to put great effort to be informed about Tesla's way of life and to understand the material of the motor so that animation can show the reality of that period in the best way (Fig. 7).

The main idea connected with animation is to select objects and layers appropriate for movement, construct the layer movements, and precisely control frame rate and timings. This is very important if someone wants to achieve maximum quality of animation. Also, animation phase is sequel to colorization. The quality of animation is directly connected with a colorization phase.

For Tesla's picture, we choose two layers: Tesla induction engine and Tesla's face - so there are two animations.

Fig.5. Tesla and the induction engine in color.

Fig.6. Original image.

Fig.7. Final image.

IV. Engine Rotor Animation

In this section of the paper will explain the animation of the final stage of Nikola Tesla color image with a rotary engine in Adobe After Effects. Before the start of this phase of the work it is necessary to process the photo into Photoshop. First we need to make a separate Layer-s for each part of the image that we want to animate. Specifically in our case, it will be the working parts of the engine. To select a tool we use *"Polygonal Lasso Tool"* with the help of which we select the

first part of the photo, or part of the engine that will later be animated. After selecting the first part it is necessary to copy that, selected, part of the new layer (Fig. 8). In this way, we copy the pixel information from the selected part of the Photo. The next step is to generate a new layer in which we end up copying.

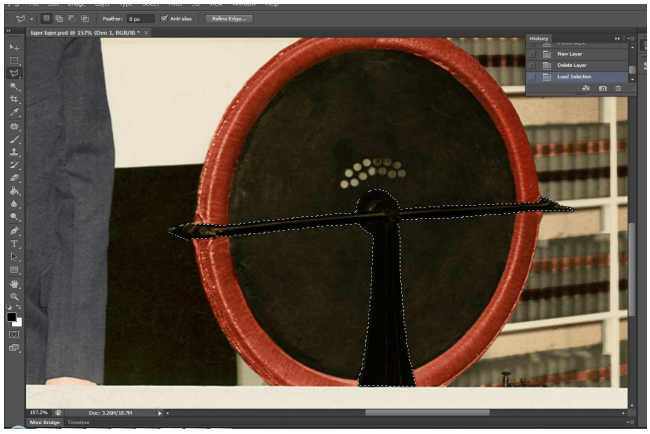

Fig. 8. Selection of the static part of the engine.

The same procedure can be applied to each portion of the image that we want to animate. In our case, that we could animate the engine, it is necessary to set aside another part of the picture. Below we use the program Adobe After Effects using the "Transform" and "Rotation". The procedure has a few steps: 1. Define layers (disk rotor and stator) 2. Define X,Y and angle parameters. 3. Define time interval. 4. Define Key-frame (the start picture). 5. Tune 1.-5. parameters and start animation. The software will generate the animation under these conditions.

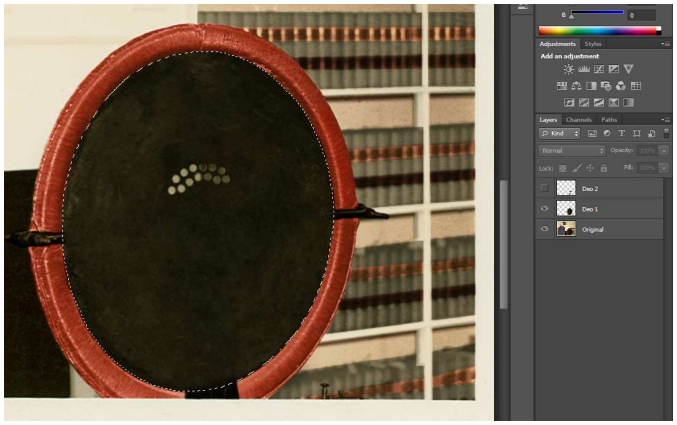

Fig. 9. Selection of the moving part of the engine (rotor).

After separation of the static and dynamic part of Tesla's motor using and adjusting the rotational transformation we obtain the rotation animation (Fig. 9). This technology is extremely useful given that there are a number of photos which can be animated by a similar procedure. The result animation could be directly insert into the digital movies.

V. Conclusion

Picture colorization will have more and more important part in many different spheres of image processing in the future. This is the fundamental issue whose improvement opens a great number of opportunities in familiar fields of research. There are great expectations related to colorization which will enable making animations which will make easier, virtual presentation, an original patent and its way of working and its appearance. In this paper we presented a novel method for picture colorization based on mixture of manual and automatic colorization method. Also, the groundwork for possible partial picture animation is presented.

Improvement of computer technology and perfection of human ability offers wide space for practical use of sometimes too complex approach of colorization which can be later gathered and made into an animation. This offers a wide range of directions for further researches towards new possibilities and the presentation of colorization and animation. This paper has offered defined results in the sphere of science till now by showing a part of the past in a visual way. The most important aim is making different kinds of picture "re-living" in 3D films that are based on pictures similar to presented one in this paper. The results in this paper are directly implemented in project developed with Nikola Tesla Museum of Belgrade and they are installed in central Museum presentation.

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