

ARTIFICIAL INTELLIGENCE OR MAN: COLORIZATION OF BLACK AND WHITE PHOTOGRAPHS

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Abstract: In this work, black and white photographs of Mate Kaić were colorized. Colorization was done manually and using several artificial intelligence software. In this research, 15 photos were colorized, the artificial intelligence needed less time than a human. By conducting an online survey and subjective evaluation, Artificial Intelligence in most cases showed a better result in the choice of colors and a more aesthetically attractive choice of combination of tones. However, artificial intelligence proved to be less intelligent with examples of photos showing traditional clothing. The results show that the best way to colorize photos is actual a combination of artificial intelligence and human.

Key words: Colorization, artificial intelligence, convolutional neural network

1. INTRODUCTION

Colorization is the process of assigning colors to a black and white photograph. The goal of every colorization is that the result is a meaningful, perceptually accurate and aesthetically appealing photograph. There are various ways to colorize black and white photos. Throughout history, various experiments have been used to leave pigment on an already finished black-and-white photograph. At that time, such processes were called manual coloring, and they were very popular already in the middle of the 19th century and even until the 1980s, with ups and downs in popularity. Today, the term manual colorization is considered digital colorization. The difference between the two manual colorizations is that with digital colorization we do not change the original photo, but it remains preserved as black and white, while in history it had to be "destroyed" with the layer of color that was applied to it. There are many reasons why people throughout history have added color to black and white photos. Nowadays, the most common reason is to "revive" old family photos (Morton, 2023; Paso Robles Daily News, 2021). The purpose of artificial intelligence in photography, as well as in all other areas in which it is applied, is to make work easier for humans. Instead of a person manually or digitally coloring a photo for hours, artificial intelligence does the whole process in a few seconds. She always tries to offer as realistic a solution as possible, this can be concluded from numerous tests of photo colorization software. The goal of every software is to render a photo as believable as possible, even if it didn't really look like that, so every software is trained on millions of photos (e.g. grass is usually green - AI is trained on examples of green grass). The difference between AI colorization and manual colorization is that a person uses his own mind to choose the colors to place on a certain part of the photo in one of the photo processing programs, while artificial intelligence chooses colors based on learned patterns. Both coloring methods have their advantages and disadvantages, and the goal is to choose the method that pays off in the best possible way in terms of quality and coloring time.

The paper is organized as follows. In Section II we give an overview of the robot design and software development, further explaining the methods used for the gameplay. Section III presents the experimental setup and obtained results, while Section IV provides discussion and comments. Finally, section V concludes the paper.

2. COLORIZATION

The term colorization refers to the process of assigning colors to a grayscale image. The reasons for colorizing black and white images can be numerous, but it is important that the image is aesthetically appealing and perceptually meaningful. If the image is colored manually, it is necessary to know the content of that image in order to achieve good quality. Objects in individual photos have different colors, so there are different ways of assigning colors to pixels in the image. So, it can be concluded that there is no single solution for colorizing images (Algoritma technical blog, 2023). In 1839, black-and-white photography

appeared for the first time with the daguerreotype process, and it was later improved by numerous other processes, such as cyanotypes, but most photographs remained black and white even until the middle of the 20th century. The period from 1900 to 1940 is also called the golden age of hand-colored photography in the West. Wallace Nutting became popular with his colorized landscape photographs of the early 20th century. He became the best-selling hand-colored photographer of all time. In the United States, Canada, Bermuda, and the Bahamas, between 1915 and 1925, hand colorization and such photographs became popular among the middle class as holiday gifts, weddings, souvenirs, and so on. However, its popularity came to an end at the beginning of the Great Depression in 1929. Today, although high-quality coloring processes are available, hand-colored photographs are still popular with some for aesthetic reasons. Also, the pigments used in manual coloring have great durability. For this reason, hand-colored photography was preferred in the 1980s due to the expensive and rare nature of color film and the unavailability of processing. Nowadays, in recent times, photo processing and colorization is possible at every step using numerous software. There are many who do not accept colorization, such as Christopher Bryant, a genealogist. According to his views, the photo should be preserved as it is, because by looking at a photo, you can determine which period it is from. So that the black and white tones show a historical feature and not just a black and white photograph. In the early days of using today's digital colorization, Maureen Taylor initially disagreed with what it offered. It raises the question why one would change color or add color to the historical value and beauty of old paintings.

AI has increasingly started to be used in mathematics, economics and operations research. At the beginning of the 21st century, machine learning techniques are advancing. In 2016, artificial intelligence reaches great popularity. Due to advances in deep learning, artificial intelligence is increasingly being used in image processing, video processing, text analysis and speech recognition.

There are many methods and algorithms that can facilitate the coloring process using artificial intelligence (Rao et al., 2022). Automatic coloring of black and white photos is becoming more and more advanced. New methods of coloring black and white photographs are being created in order to display the results as authentically as possible. There is always an effort to improve algorithms for colorizing black and white photos, and the desire is to write such a good algorithm whose results will show such accurate and correct photos that people will not know if the photo is original or colored.

It is possible to separate the subject and aesthetics of several images and then recombine them into a single image using a pre-trained convolutional neural network first developed for image categorization. A convolutional neural network (CNN) consists of multiple layers of small computing units that process only parts of the input image in a feed-forward manner. Each layer is the result of applying different image filters, each of which extracts a specific feature of the input image, to the previous layer. Therefore, each layer can contain useful information about the input image at different levels of abstraction (Figure 1) (Smith, 2019).

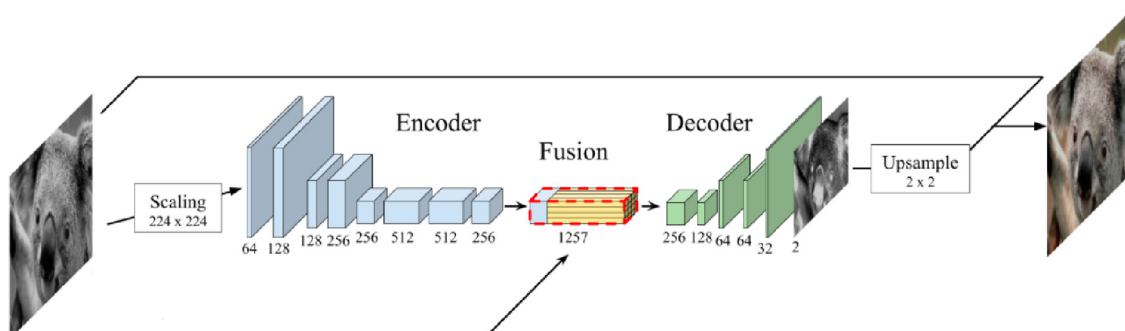


Figure 1: Colorization by convolutional neural network

3. RESEARCH

15 photos of Mate Kaić were used for colorization. Two websites were chosen for coloring: myheritage.com and img2go.com.

Myheritage.com is a free genealogy website that allows you to upload black and white photos and automatically colorize them using artificial intelligence. The site's colorization algorithm is trained on

historical photos, so it tends to produce more accurate colors. The site also includes additional functions such as Color Restoration, also a DeOldify product. This feature restores colors to photos originally taken in color that have faded or were not captured or processed well in the first place. Adobe Photoshop was used for manual colorization.

A survey was conducted and posted on Facebook pages. There were 61 respondents in total. The survey consisted of 15 questions. The focus was on the photographs, and the survey did not ask the gender and age of the respondents. Each question contained only two photos, one that was colored by hand and one that was colored by artificial intelligence. The respondent was asked which photo, in his opinion, shows the correct colors.

4. RESULTS AND DISCUSSION

The Figures 2 and 3 show the results of manual colorization (picture on the left) and colorization by artificial intelligence (picture on the right). Figure 2 shows the old folk costume of the Livonian region, which consists of a red cap, a bluish waistcoat, and a red belt; AI fell. For photo shown in Figure 3, human did a better job than artificial intelligence. The differences are obvious, they can best be seen on the example of a wooden roof. The Figure 4 shows the results of the survey, which picture reproduces the colors better. Most respondents were not from the city of Livno, they could not know the traditional folk costume. It is assumed that this is one reason why their colors were more natural in the right photo.



Figure 2: Colorization by convolutional neural network



Figure 3: Colorization by convolutional neural network



Figure 4: Colorization by convolutional neural network

The difference between human and AI can be seen in some traditional details of the images, and in case when the AI needs to recognize what season it is. AI colorized images have better tones and more vivid colors, and the colorization time is much shorter.

5. CONCLUSIONS

In most cases, artificial intelligence showed a better result in the choice of colors and a more aesthetically attractive choice of tone combination. However, artificial intelligence proved to be less intelligent with examples of photos showing traditional clothing. With those photos, it was important to know history and tradition. For this reason, it can be mentioned that artificial intelligence is still not sufficiently developed to be able to replace humans in such situations. It really took a lot more time for a person to colorize a certain photo. In this case, artificial intelligence has many more advantages. In the example of this work, 15 photos were colored, which means a lot of work and concentration for a person, which is not always possible with so many tasks. In conclusion, it can be said that the best way to colorize photos is a combination of artificial intelligence and human intelligence. In many cases, artificial intelligence has proven to be better and more cost-effective when it comes to color selection and performance time, but it still needs to be historically accurate.

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