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Manipulating Pixels, Graphic Images and Video Using Javascript

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ABSTRACT

Working with pixels, changing, or using their RGBA values, using JavaScript and more precisely the p5.js library is discussed. Filters have been created, which manipulate pixels in images or video. The topic of steganography and storage of information in an image through pixels has also been analysed.

Keywords: JavaScript, p5.js, image, filter, video, pixel, camera, steganography.

INTRODUCTION

The aim of the manuscript is demonstrating ability to create video and image effects. Different types of techniques and methods for filtering distinct pixels in images and video footage is shown. A certain cryptography called steganography is introduced, using methods and techniques of manipulating the individual pixels of images or video frames.

EXPERIMENTAL

The library p5.js [1, 2] and the provided by its creators online editors has been used. p5.js editor is open source. In this project are used differing methods and techniques for pixel manipulation in images and video frames. We decomposed the individual pixel into so-called RGBA values, these values representing the red, green, and blue components of the color and "transparency" of the individual pixel. By changing these values, we obtained various effects and filters related to both the individual colors and the geometry of the image itself. By manipulating and adding new information to these variables, we were able to encrypt information in images or video frames. The new images thus obtained are indistinguishable from the original ones.

RESULTS AND DISCUSSION

Pixels are the main building block of any digital image [3]. They have variable color and brightness. These two quantities are in the RGBA scale. The array through which the pixels are reached in JavaScript stores these four values of each pixel in that order. The RGBA elements of a pixel with coordinates (0; 0) are 0, 1, 2, 3, and of a random pixel with coordinates (x, y) are obtained from the formulas:

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$$R = (x + W.y) * 4 + 0\, R = (x + W.y) * 4 + 0 \quad (1)$$

$$G = (x + W.y) * 4 + 1 G = (x + W.y) * 4 + 1 \quad (2)$$

$$B = (x + W.y) * 4 + 2 B = (x + W.y) * 4 + 2 \quad (3)$$

$$A = (x + W.y) * 4 + 3 A = (x + W.y) * 4 + 3 \quad (4)$$

In these formulas *R* represents the red value, *G* - the green value, *B* - the blue value and *A* - transparency. *W* is the width of the image in pixels.

In this way, we can manipulate the colour and brightness of every pixel on our canvas and extract information from them.

Fig. 1 shows an image broken down to its RGB values.

Manipulation of pixels and image filters

Filters can be creating by changing the colour of the pixels. A simple example is the mirror effect shown in Fig. 2. There the colour values of the upper half of the image are given to the ones in the lower part of the image. Similarly, if we change only one of the color values of the pixels, we will get a colored image (Fig. 3). The content of the original image is understandable with this change, because the other two unchanged color values are sufficient to convey the information.

Filters such as those shown in Fig. 4 can also be created by such manipulation. It uses a circle packing algorithm. This is an algorithm for placing as many circles as possible in a certain space without overlaping [4]. With this method, circles are superimposed on the canvas. The colors of the circles are chosen from the color of

Fig. 1. The original image (top right) and images that are composed of only one of the RGB values of the original image [6].

Fig. 2. Mirror effect (original image on the left, filtered image on the right) [6].

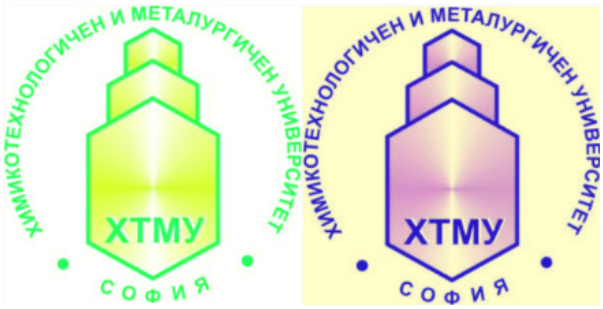

Fig. 3. Images with one colour variable changed (G=255 in the image on the left, B=200 in the image on the right) [6].

Fig. 4. Circle packing filter [6].

the pixels in their centers. In this way, an infinite number of different other images can be obtained from one image.

Filters for video taken from the device's camera

These filters again use pixel color information, and some of the above filters can be customized for video. In this case, however, the information is not static. This allows the creation of more dynamic filters. One of them is shown in Fig. 5. In it, the row of pixels in the middle of the video is copied to the canvas, each time the line is placed below the previous one, and when the canvas is finished, the new lines are placed in place of the previous ones. This is similar to the image filter shown in Fig. 2 - the color data of a given row is copied onto the canvas.

The filter shown in Fig. 6 uses a grid of squares, giving them the colors of the pixels in their centers. In this way a pixelated image is obtained. This filter can be made with other shapes such as circles, triangles and more.

It is also possible to use the "brightness" of the colors, which is obtained from the arithmetic mean of the RGB values of the pixels. This is shown in Fig. 7. Again, a grid of squares is used, but unlike the previous filter, this one changes the size of the squares, not their color depending on the "brightness" of the pixel in the center of the square, as an arithmetic mean at 0, the white square is as large as possible.

The filter shown in Fig. 8 uses the so-called random walk. This is an element that moves at random. In this case, circles are used that move randomly and form an image corresponding to the content of the video frame. The wandering element acquires the value of the color that corresponds to the color of the pixel in its center.

Fig. 5. Video effect with copying a row of pixels.

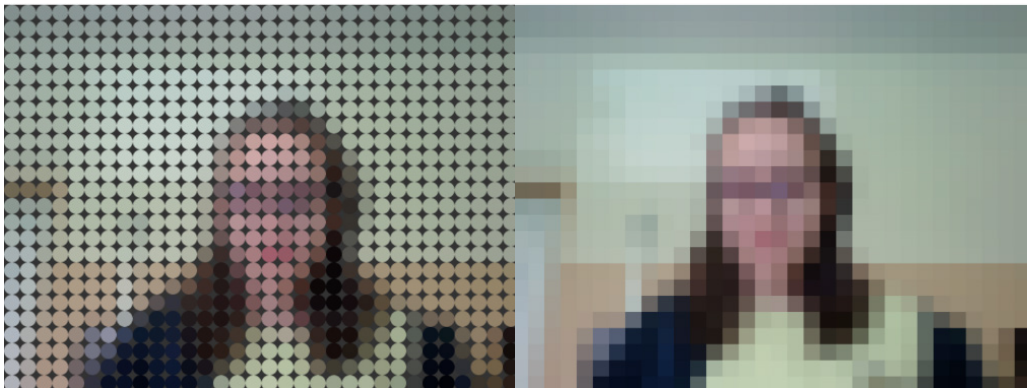

Fig. 6. Video effect: pixelization.

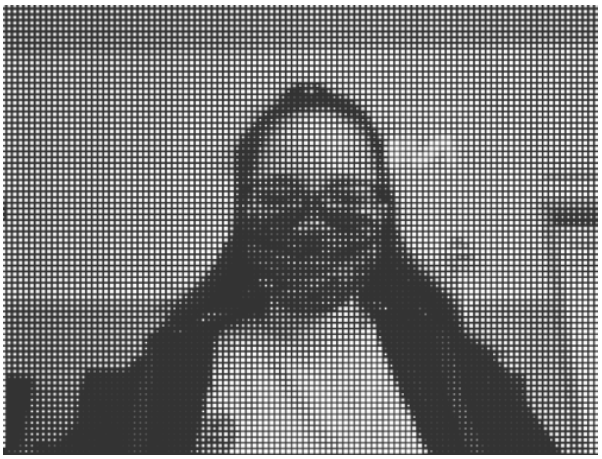

Fig. 7. Video effect: brightness

Fig. 8. Video effect: random walk

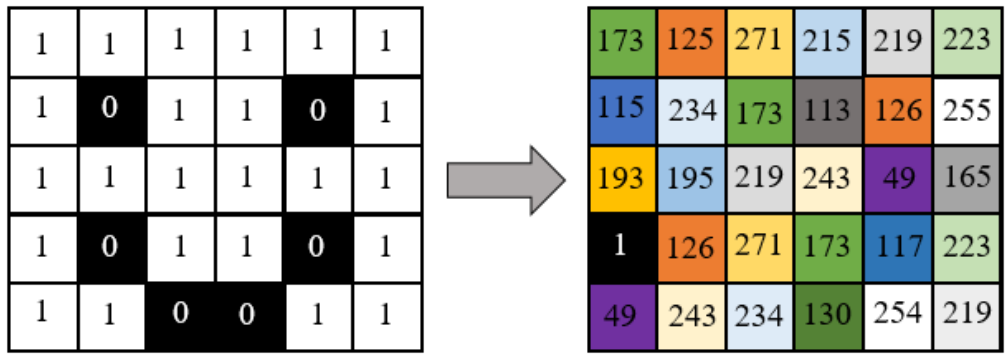

Fig. 9. Demonstrating steganography

Fig. 10. The image on the left does not carry information and the one in the middle - does. The image on the right is "hidden" in the one in the middle [7].

Steganography

Steganography from Greek means covert writing. This is the science of encrypting messages in such a way that only the sender and recipient know about the existence of hidden information [5]. This is the science of encrypting messages in such a way that only the sender and recipient know about the existence of hidden information. In this case we are considering, an image is used as a carrier of the hidden information. It hides another black and white image of no larger size. The black pixels of the secret image are saved as 0 and the white pixels as 1 (Fig. 9). Depending on the numerical value of the pixel from the hidden image, the values of the RGBA components of the pixels from the visible image change to even or odd. A simple implementation would be to change a specific component of the RGBA values as it is coded to be even or odd. In our implementation, the black pixels of the hidden image correspond to an even green value of the pixels in the visible image. Accordingly, the white pixels of the hidden image correspond to an odd value of the pixels in the visible image. Thus, the difference between the original image and this information carrier is invisible to the eye - only the encoder and the recipient know about the hidden image (Fig. 10).

CONCLUSIONS

This report demonstrates the manipulation of pixels from photos and videos and possible applications that can be used for practical purposes. Various filters have been developed for

both image and video. Pixel manipulation provides opportunities for both encoding information and creating various graphic effects. Using the pixel manipulation methods and techniques described in this report, it is possible to develop additional filters for graphic and video effects, as well as information encryption methods.

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