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Review on Image Recoloring Methods for Efficient Naturalness by Coloring Data Modeling Methods for Low Visual Deficiency

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ABSTRACT

Recent research has discovered new applications for object tracking and identification by simulating the colour distribution of a homogeneous region. The colour distribution of an object is resilient when it is subjected to partial occlusion, scaling, and distortion. When rotated in depth, it may remain relatively stable in other applications. The challenging task in image recoloring is the identification of the dichromatic color appearance, which is remaining as a significant requirement in many recoloring imaging sectors. This research study provides three different vision descriptions for image recoloring methods, each with its own unique twist. The descriptions of protanopia, deuteranopia, and tritanopia may be incorporated and evaluated using parametric, machine learning, and reinforcement learning techniques, among others. Through the use of different image recoloring techniques, it has been shown that the supervised learning method outperforms other conventional methods based on performance measures such as naturalness index and feature similarity index (FSIM).

Keywords: Image recoloring, naturalness index, dichromacy

1. INTRODUCTION

In some cases, dichromats and monochromats may experience colour vision impairment. Children may become angry due to their inability to do some color-related tasks, and adults may

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struggle to complete certain daily duties. Understanding scientific and information visualization data in professions such as biology, chemistry, geology, fashion design, electronics, and others may be more challenging for color-vision-impaired individuals [1-5]. Figure 1 shows some sample set of painting for recoloring process.

Color is detected by photoreceptor cells called "cones" in the retina of the human eye. L-cones, M-cones, and S-cones are the three main types of cones. Due to its sensitivity to overlapping areas of the visible spectrum, these cone may be described as nuanced [6, 7].

Figure 1 sample set of painting for recoloring

Using color image investigation, individuals who are visually challenged have gained a better sense of their surroundings [8, 9]. Recoloring the original picture to meet various criteria, such as image naturalness and color contrast improvement, are among the most important ways to reduce the impacts of color vision deficiency (CVD). Minimizing the perceived difference between the original and the recolored picture is the main goal of the image naturalness design approach. Also, increasing the color contrast would be very handy for assisting color blind individuals with object identification [10-12]. Figure 2 shows some differences for various descriptions obtained from the normal vision.

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Color-blindness may be mitigated by using various picture recoloring techniques. Designs for image recoloring algorithms must always meet specific requirements. Priority must be given to colour naturalness as well as the preservation or enhancement of colour contrast. [13].

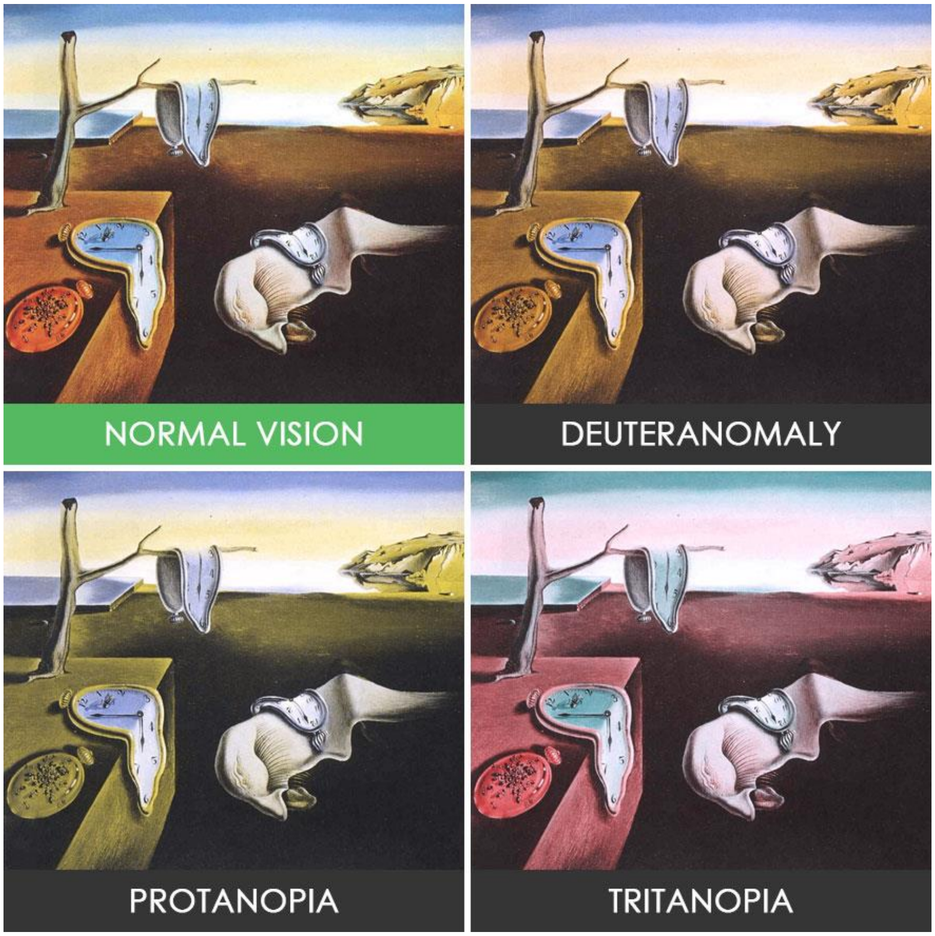

Figure 2 Differences in Various Vision Descriptions

The term naturalness measures the color distribution and aesthetic resemblance between the original and recolored images. Contrast is a fundamental component of object identification and color discrimination, which is especially important for color-blind people [14-16].

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2. ORGANIZATION OF THE RESEARCH

The rest of this review research article is organized as follows; section 3 discusses about the existing research works in the recoloring process for the images. Section 4 discusses about the various modeling techniques involved in coloring the data model. Section 5 provides the difference about various modeling techniques of coloring data model with performance metrics. The proposed research work is concluded in section 6.

3. PRELIMINARIES

Vienot et al have developed a computational model for dichromatic color vision. Here, the researchers state Protanopia and deuteranopia as the different stages of normal trichromatic vision. They discovered a dichromatic color gamut as a flat two-dimensional space in RGB color space [17].

Kuhn et al. have created a set of CIELab colors based on the red-green-blue (RGB) dichromatic simulated gamut, and they called this as the “key color set." They were concerned with the distance between key colors and their projections on the Lb plane, and therefore the objective function has been eliminated. After adjusting the Lb plane colors, the Lb plane was finally turned to match. However, it increases the contrast, where the technique ultimately alters the colors and distorts the naturalness [18].

Han et al have used the CIELab space, which divides the picture into areas and selects color representations that are representative of the original image. The colors found in the confusion lines have been moved to all areas in order to allow the color-blind to be distinguished. Even yet, the number of confusion lines chosen was more than the number of wavelengths that color-blind people can visualize. When colors from two or more confusing lines become mixed, it becomes difficult to obtain the difference between the new colors and the old ones, resulting in decreased contrast in the image processing [19].

Huang et al have used mixture modeling to divide the colours into clusters in the CIELab space, and the results were published in Nature Communications. Generalized to measure the dissimilarity between pairs of distributions, the distance between pairs of cluster centers was

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used. A minimization function was used to ensure an efficient recoloring of the original image by considering the existing differences. The contrast increase in the aforementioned technique provides better colour control for perplexing colours but colour naturalness may be negatively impacted since there is no control over hue shifts [20].

Kang et al ran a simulation lab and established a key colour palette based on it. By determining the difference between two sets of individuals, the authors calculated the resultant difference vector and projected it onto the colour plane perceived by dichromats, which is a three-dimensional space. Then, they tried to enhance the local contrast between colour areas of the picture while attempting to reduce the overall image contrast. Even while the contrast-boosting technique helps, there is no way to maintain the naturalness of the image, which may be lost [21].

4. METHODOLOGIES

Coloring Data Model

To automate a visual process, a computer model that replicates how humans execute the task must be created. Color modelling is one approach that has been utilized to create models for color difficulties [22]. Based on pattern recognition, the models determine which many groupings may be classified into these two categories:

4.1 Parametric Model

The computer models the real-world behaviour by creating 3D objects or systems that represent component characteristics. Feature-based, solid, and surface modelling design tools are used to adjust the system characteristics through parametric models. There are numerous advantages to use metric modelling. One of them is that, the linked attributes change their characteristics automatically. It is the same as saying that parametric modelling allows designers to describe whole classes of shapes rather than just specific samples. Parametric design alters the form far more difficult before its development. Additionally, the 3D solid needed to be modified such that its length, width, and height could be modified. The designer just has to change one parameter, while the other two values are automatically updated. To be more specific, parametric

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models concern themselves with the procedures that are followed while producing a form and parameterize them [23]. This is good for the service providers of product design engineering.

Mathematical equations serve as the foundation for parametric models. Without any merit, parametric models cannot be considered legitimate. To determine the feasibility of a modelling solution, it is the modernity of the information examination methods and the extent of the concealed undertaking information that is essential.

4.2 Non Parametric Model

Color distributions for areas of homogeneity have been modeled using parametric and non-parametric statistical methods. The three-dimensional distribution of color was modeled using a single Gaussian. If a single Gaussian function is used to describe the colour of an object, it can only represent colours that are of a single hue. This is an inadequate assumption to simulate areas with a mixture of hues. Patterns and a range of colours are common in the fabric and surfaces of things that are textured. An effective method to fit colour blobs with a combination of colours is to use the EM algorithm to model them with a mixture of Gaussians. The method of using colour to track a single blob was also used for facial tracking. Selecting the correct number of Gaussians for the given model is a difficulty with the Gaussians method (model selection). The nonparametric histogram methods have been extensively utilized to deal with the aforementioned difficulties when employing parametric models for characterizing the colour of an item [24]. People have tracked the primary usage of the concept by using colour histograms.

4.3 Semi Parametric Model

This model is a partial process of parametric model for color data modeling. Because it's less linear, the non-linear function (xq) offers more flexibility and, theoretically, better accuracy in prediction and effect assessment. These two major benefits also bring with them several potentially significant drawbacks.

1. Non-linear models may overfit the data, and their performance will thus be lower than that of linear models.

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2. Even though the estimate may offer a significant computing problem, we're going to try it nonetheless.

Because of this, interpreting the results may be challenging. Incorporating basic splines as an additive or building block in a 3D model's design creates the undesirable task of picking a specific set of support points. To ensure that the splines accurately represent the non-linearity of the modelled function, the number of support points should be chosen judiciously. The second possibility is that the model is significantly over parameterized if the number of support points is too high. Regional freight modelling (or any freight modelling for that matter) often makes use of cross-sectional data or small-scale panels for making inferences. This issue has many possible solutions

4.4 Supervised Learning

After we have gathered enough knowledge about the data, we may use supervised learning. When supervised learning is used, we show the relationship between various factors and previously determined outputs. The variables in supervised machine learning include labeled sample data and known output, which is known as the right output. Input data is the variable whose values serve as the independent variable. This way of modeling can be performed to compute the related variable in the machine learning process of clustering. Supervised learning involves setting a certain assignment and assigning that work to one of three categorization categories illustrated in Figure 3.

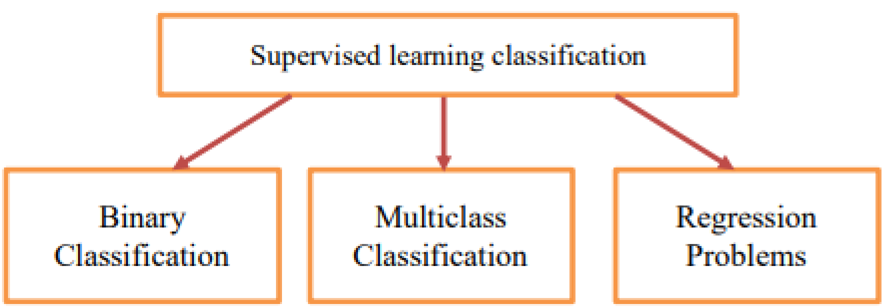

Figure 3 supervised learning classification

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4.5 Unsupervised Learning

Unsupervised learning requires trial and error learning and improvement. This type of machine learning has nothing to do with labeled data, which gives the right response, or a demonstration of the correct answer. Rather, the machine has been designed to do independent data analysis and produce connections on its own. Unsupervised learning is a method that uses data to cluster objects. Unlabeled data comes into the machine by analyzing the data. By providing machine clusters, the data is divided into distinct categories. With unsupervised learning, it is important to have access to a large quantity of data. The greater the amount of data, the simpler it is for a computer to see and follow patterns that may result in an important group [25].

4.6 Reinforcement Learning

The distinction between reinforcement learning and supervised and unsupervised learning is important. Since the system iterates to better results, reinforcement learning is used. To some degree, the machine will converge on the ideal output over time. An algorithm learning to respond to the environment is an example of reinforcement learning. You are making the computer do what you want by constantly rewarding that behavior. We gave the machine a clearly defined objective instead of just studying and observing. Q-learning is an example of reinforcement learning, and it is an exciting field of machine learning research. It is possible for a computer to both play games and execute algorithms, and then examine the outcomes of those players. A computer can learn and retain algorithms when a good occurrence happens.

5. RESULTS & DISCUSSION

The characteristics are given to the dichromatic simulation of the recolored painting during the simulation of the painted work [26]. Here, figure 3 shows some sample input image collection for recoloring process.

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Figure 3 sample image collection for recoloring process

For protanopia, deuteranopia, and tritanopia, the feature similarity index is used. The extremely comparable and successful recolored procedure is shown by the lowest value of naturalness index for the process of modelling. In this part, the paintings in two images (painting 1 and 2) are used as a visual comparison to investigate the findings for protanopia. Though the supervised learning is colorized picture, it improves the contrast of the portrayed cows, as observed in Painting 1 and 2. It also makes the backdrop and the grassless jarring gentler by making the entire picture more natural. Figure 4 shows the 2 type of paintings. The naturalness index can be defined as follows;

$$Naturalness\ Index = \frac{1}{NM}\sum_{k=1}^{N}\sum_{t=1}^{M}\left\|P_{kt} - P_{rec,kt}\right\|$$

Figure 4 comparison of original and maximum fsim index picture (1 & 2)

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This indicates that the chrominance information of the recolored paintings is near to the original ones, since supervised learning achieves competitive performance when compared to the other techniques.

Table 1 Naturalness Index for the Case of Protanopia

Images	PM	N-PM	S-PM	SL	U-SL	Reinforced Learning
Painting 1	13.4	14.5	34.01	7.234	15.5	14.3
Painting 2	18.3	20.5	29.1	3.945	8.5	10.23

Table 2 Naturalness Index for the Case of deuteranopia

Images	PM	N-PM	S-PM	SL	U-SL	Reinforced Learning
Painting 1	14.34	12.45	15.34	6.213	17.23	10.45
Painting 2	20.3	24.5	16.12	4.452	18.34	9.45

Table 3 Naturalness index for the case of tritanopia

Images	PM	N-PM	S-PM	SL	U-SL	Reinforced Learning
Painting 1	11.5	18.56	15.89	15.456	19.7	16.98
Painting 2	19.72	19.34	29.5	18.765	22.3	19.00

The main distinction is that protanopia and deuteranopia simulations of the recolored picture show distinct differences. Because these quantitative findings are the same for the protanopia and deuteranopia instances, the results produced using this technique are comparable.

Table 4 FSIMc index for the case of protanopia (%)

Images	PM	N-PM	S-PM	SL	U-SL	Reinforced Learning
Painting 1	70.56%	73.5%	65.5%	96.72%	93.5%	90.1%
Painting 2	72.4%	82.5%	88.5%	95.234%	83.5%	83.4%

Table 5 FSIMc index for the case of deuteranopia (%)

Images	PM	N-PM	S-PM	SL	U-SL	Reinforced Learning
Painting 1	68.5%	63.6%	56.34%	94.123%	88.86%	82.3%
Painting 2	69.3%	71.5%	72.1%	89.991%	89.34%	80.46%

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Table 6 FSIMc index for the case of tritanopia (%)

Images	PM	N-PM	S-PM	SL	U-SL	Reinforced Learning
Painting 1	69.8%	76.4%	77.5%	85.34%	80.5%	83.5%
Painting 2	71.2%	78.5%	78.3%	87.997%	82.4%	86.4%

The values specified by FSIMc are represented as percentages and chrominance information on the recolored picture is quantified relative to the original image. As a result, the chrominance information of the recolored picture is closer to the chrominance information of the original image. Figure 5 shows comparison of various methods of image recoloring techniques.

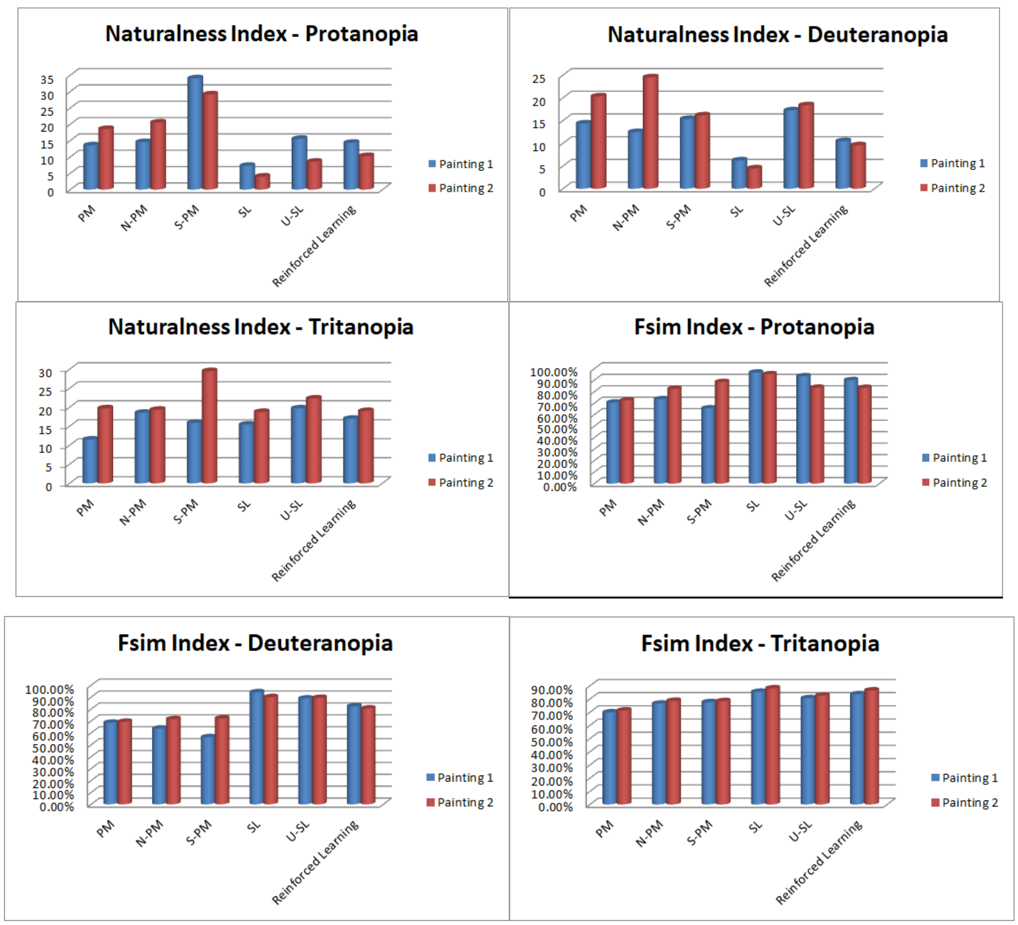

Figure 5 Comparison of various methods

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The supervised learning process modeling has provided great performance than other traditional recoloring methods. These graphs are showing overall performance and it proves supervised learning process modeling as greater performance. The feature similarity index can be computed by the following formula.

$$\boldsymbol{Fsim} = \frac{\sum_{kt} S_{PC,kt}\, S_{G,kt}\left(S_{I,kt}, S_{Q,kt}\right)^{2} PC_{max,kt}}{\sum_{kt} PC_{max,kt}}$$

Where,

I and Q are chromaticity channel

PC is phase congruencies

G is gradient magnitude

p_{rec} is recolored image

$1 \leq k \leq N \; and \; 1 \leq t \leq M$

6. CONCLUSION

We conclude this paper in light of the aforementioned review, which includes detailed validation of the picture recoloring approach and a large collection of experimental studies. We discovered that performing the validation has improved the performance of the other recoloring techniques. Naturalness and feature similarity index measures may be used to calculate the overall performance assessment for paintings 1 and 2. In the preceding result, and the part of its explanation, you can see the comparison graph chart. Feature similarity index supervised learning is more effective in machine learning. Going forward, the future path of research might be defined as such:

1. To overcome the tritanopia and anomalous trichromacy flaws, the technique has been extended.
2. Advancement in machine learning in the recoloring process with a vast quantity of information is expected.
3. To maintain a suitable balance between naturalness preservation and contrast augmentation, the implementation of more complex optimization method is required.

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REFERENCES

[1] Sungheetha, Akey, and Rajesh Sharma. "3D Image Processing using Machine Learning based Input Processing for Man-Machine Interaction." Journal of Innovative Image Processing (JIIP) 3, no. 01 (2021): 1-6.

[2] Sharma, Rajesh, and Akey Sungheetha. "An Efficient Dimension Reduction based Fusion of CNN and SVM Model for Detection of Abnormal Incident in Video Surveillance." Journal of Soft Computing Paradigm (JSCP) 3, no. 02 (2021): 55-69.

[3] Choi, J.; Lee, J.; Moon, H.; Yoo, S.J.; Han, D. Optimal color correction based on image analysis for color vision deficiency. IEEE Access 2019, 7, 154466–154479.

[4] Dutta, Sayantan, and Ayan Banerjee. "Highly Precise Modified Blue Whale Method Framed by Blending Bat and Local Search Algorithm for the Optimality of Image Fusion Algorithm." Journal of Soft Computing Paradigm (JSCP) 2, no. 04 (2020): 195-208.

[5] Meng, M.; Tanaka, G. Lightness modification method considering visual characteristics of protanopia and deuteranopia. Opt. Rev.2020, 27, 548–560.

[6] Pandian, Dr A. Pasumpon. "IMAGE INPAINTING TECHNIQUE FOR HIGH QUALITY AND RESOLUTION ENHANCED IMAGE CREATION." Journal of Innovative Image Processing 1, no. 1: 39-50.

[7] Karuppusamy, P. "Building Detection using Two-Layered Novel Convolutional Neural Networks." Journal of Soft Computing Paradigm (JSCP) 3, no. 01 (2021): 29-37.

[8] Rigos, A.; Chatzistamatis, S.; Tsekouras, G.E. A systematic methodology to modify color images for dichromatic human color vision and its application in art paintings. Int. J. Adv. Trends Comput. Sci. Eng. 2020, 9, 5015–5025.

[9] Bindhu, V., and G. Ranganathan. "Hyperspectral Image Processing in Internet of Things model using Clustering Algorithm." Journal of ISMAC 3, no. 02 (2021): 163-175.

[10] Martínez-Domingo, M.Á.; Valero, E.M.; Gómez-Robledo, L.; Huertas, R.; Hernández-Andrés, J. Spectral filter selection for increasing chromatic diversity in CVD subjects. Sensors 2020, 20, 2023.

[11] Chen, Joy Iong-Zong. "Design of Accurate Classification of COVID-19 Disease in X-Ray Images Using Deep Learning Approach." Journal of ISMAC 3, no. 02 (2021): 132-148.

ISSN: 2582-2012 (online)
Submitted: 17.07.2021
Revised: 06.08.2021
Accepted: 18.08.2021
Published: 27.08.2021

[12] Palani, U., Mrs D. Vasanthi, and Ms S. Rabiya Begam. "Enhancement of Medical Image Fusion Using Image Processing." Journal of Innovative Image Processing (JIIP) 2, no. 04 (2020): 165-174.

[13] Simon-Liedtke, J.T.; Farup, I. Multiscale daltonization in the gradient domain. J. Percept. Imaging 2018, 1, 10503-1–10503-12.

[14] Sathesh, A. "Light Field Image Coding with Image Prediction in Redundancy." Journal of Soft Computing Paradigm 2, no. 3 (2020): 160-167.

[15] Farup, I. Individualised Halo-Free Gradient-Domain Colour Image Daltonisation. J. Imaging 2020, 6, 116.

[16] Adam, Edriss Eisa Babikir. "Survey on Medical Imaging of Electrical Impedance Tomography (EIT) by Variable Current Pattern Methods." Journal of ISMAC 3, no. 02 (2021): 82-95.

[17] Vienot, F.; Brettel, H.; Mollon, J.D. Digital Video Colourmaps for Checking the Legibility of Displays by Dichromats. Color Res. Appl. 1999, 24, 243–252.

[18] Kuhn, G.R.; Oliveira, M.M.; Fernandes, L.A.F. An efficient naturalness-preserving image-recoloring method for dichromats. IEEE Trans. Vis. Comput. Graph. 2008, 14, 1747–1754.

[19] Han, D.; Yoo, S.J.; Kim, B. A novel confusion-line separation algorithm based on color segmentation for color vision deficiency. J. Imaging Sci. Technol. 2012, 56, 1–17.

[20] Huang, J.-B.; Chen, C.-S.; Jen, T.-S.; Wang, S.-J. Image recolorization for the color blind. In Proceedings of the 2009 IEEE Inter-national Conference on Acoustics, Speech and Signal Processing (ICASSP 2009), Taipei, Taiwan, 19–24 April 2009; pp. 1161–1164.

[21] Kang, S.-K.; Lee, C.; Kim, C.-S. Optimized color contrast enhancement for dichromats suing local and global contrast. In Proceedings of the IEEE International Conference on Image Processing (ICIP), Abu Dhabi, United Arab Emirates, 25–28 October 2020; pp. 1048–1052.

[22] Faizal, N., S. Sharan, Panchami S. Nair, and Devi S. Sankar. "Securing Color Image Using Combined Elliptic Curve Crypto-System and Hill Cipher Encryption Along with Least Significant Bit-Steganography." In International Conference on Inventive Computation Technologies, pp. 351-361. Springer, Cham, 2019.

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[23] Kumar, C. Ashok, and S. Sathiamoorthy. "Medical Image Retrieval Using Efficient Texture and Color Patterns with Neural Network Classifier." In International conference on Computer Networks, Big data and IoT, pp. 539-546. Springer, Cham, 2019.

[24] Manikandan, C., N. Raju, K. Sai Siva Satwik, M. Chandrasekar, and V. Elamaran. "Generation of Random Binary Sequence Using Adaptive Row–Column Approach and Synthetic Color Image." In Computer Networks, Big Data and IoT, pp. 103-113. Springer, Singapore, 2021.

[25] Patil, Kiran H., and M. Nirupama Bhat. "Survey of Color Feature Extraction Schemes in Content-Based Picture Recovery System." In Computational Vision and Bio-Inspired Computing, pp. 719-732. Springer, Singapore, 2021.

[26] Anitha, S., and S. Madhusudhan. "Validating Retinal Color Fundus Databases and Methods for Diabetic Retinopathy Screening." In Computational Vision and Bio-Inspired Computing, pp. 747-769. Springer, Singapore, 2021.

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A. Pasumpon Pandian has completed his UG and PG degree from the reputed colleges and works as Professor and Dean (R&D) in CARE College of Engineering, Trichy, India. His area of research includes Social Networks, Wireless Networks, Internet of Things, Computer Networks, Mobile Communication, Robotics and Electrical Infrastructure, Mobile APIs, Data Analysis and Visualization.

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