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Deep Learning-Based Machine Color Emotion Generation

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ABSTRACT

This paper investigates generating machine color emotion through deep learning. The grayscale image colorization model's training process resembles human memory color. Sixty images were recolored and quality evaluated to explore machine generated color impressions. Six experimental samples were recolored under D65, A, CWF, and TL84 light sources. Changes in lightness, chroma, and hue angle compared the original and colorized images, exploring light source effects on machine color perception. Analyzing differences in coloring results within the CIEL* a* b* color space for pixels with equal grayscale verified machine color emotion generation. Results show the machine learns to form color impressions from samples. Different light source color temperatures impact color prediction accuracy. The machine accurately colors images based on semantic context, demonstrating spontaneous color emotion generation through deep learning. This research positively contributes to the development of intelligent devices with color emotion.

KEYWORDS

Artificial Intelligence, Color Emotion, Color Perception, Deep Learning, Light Source

INTRODUCTION

Emotional intelligence is an advanced stage in the development of artificial intelligence (AI); it is at the forefront of contemporary information development, and a new product that incorporates emotion into the field of information science. The extended cognitive theory argues that with the development of computer and AI technologies, human cognitive activities must rely on intelligent devices to be completed. The cognitive subject not only is an individual natural person but also includes these electronic devices, which are cooperative or symbiotic (van Holland, 2013). It provides ideas that can be applied to developing AI and emotional machines. Developing emotional robots is a trend and requirement for changing weak AI to strong AI and super AI (Fjelland, 2020). The creation process

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has eight steps: discovering the problem, acquiring knowledge, gathering relevant information, conceiving ideas, generating ideas, combining ideas, selecting the best idea, and externalizing the concept. Today's machines are not equipped with the ability to discover problems and formulate them, nor can the data selection and collection rules be set by the devices themselves. However, in data processing, data has an advantage that humans cannot match. In this case, the model of human-machine collaboration is still the optimal solution. Suppose the ability of emotion recognition and expression is given to machines. In that case, this advancement will not only push AI to a higher platform but also assist in human emotion understanding and expression. It will also facilitate the overall development of human beings (Korsmeyer, 1999).

Although previous researchers have described the creation of many robots and architectures for autonomous agents that can mimic human emotion, most of this research has focused on social domains, such as medical services (Esteva et al., 2017), teaching services (Ling, 2022; Yang, 2022), and family services (Breazeal, 2003; Lee-Johnson & Carnegie, 2010), mainly possessing speech recognition communication technologies (Lafaye et al., 2014).

In contrast, robots with color emotion have been less developed. There are few applications in the field of color perception and art creation. However, vision is the most potent way humans perceive objective things in communication with the outside world (Li et al., 2022). More than 87% of people obtain information visually, with 70% to 80% of this information obtained from color (Wu & Fang, 2022; Xu et al., 2022), so the emotion conveyed by color is essential (He & Lv, 2022). Color emotion refers to the light information of different frequencies of color acting on the human visual organs, through the optic nerve to the brain, and then associated with memories and experiences, thus forming a series of color psychological responses.

A colorimeter obtains the current machine perception of color by measuring the spectral properties of the material surface to obtain color data, which for color perception, remains only at the level of physical properties and color measurement. This measurement is formed by three links: light source, object, and sensor. However, color is a subjective response of the human visual system to electromagnetic radiation in the visible spectrum with wavelengths between 380 nm and 780 nm. Four factors are required to form human color perception: the light source, the object, the eye, and the brain. Human color perception involves physics, physiology, and psychology (Zeger et al., 2021); therefore, compared with humans, machines lack psychological perception of color, and their perception of color does not resonate with humans. This limitation hinders better human-machine communication and collaboration.

Nowadays, many artists have gradually moved away from traditional paper-based creations and embraced artistry using mobile smart devices. If machines possess color emotion, they can synchronize their color perception with the creators and stimulate their inspiration by autonomously learning and performing image coloring. By combining color emotion with mobile smart devices, users can engage in creative activities more conveniently on their mobile devices while enjoying intelligent creative assistance and personalized artistic experiences. Thus, determining how to make machines acquire color emotion is one of the urgent challenges to be solved.

Deep learning, one of the most rapidly developing branches of AI, can fill this gap because the field of visual perception in AI has some relevance to the processing of visual information in primate brains. To maximize the simulation of human color perception, we investigated the generation of machine color emotions and propose a "machine vision system," which consists of four elements: light source, object, sensor, and "emotional intelligence system." We used grayscale image coloring models for experiments. First, we trained the coloring model with a large number of samples for simulating AI to form color impressions. Second, we explored the importance of color appearance factors in perceiving color by changing the light source. Finally, we analyzed the color prediction process of the system to understand the process of machine-generated color emotion. This process is similar to the process of human memory and association of colors, so deep learning is the way to generate color emotion and gain color intelligence.

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