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FUZZY SET THEORETICAL APPROACH TO ACHROMATIC RELEVANT COLOR ON THE NATURAL COLOR SYSTEM

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Abstract. *The present study considers a fuzzy natural color system (NCS) in which triangular pyramid membership functions are constructed on the NCS color triangle. This system can process a fuzzy input to an NCS and output a center of gravity of three weights associated with respective grades. Triangular membership functions are applied to the hue angle, and triangular pyramid membership functions are applied to the NCS color triangle relationship. By treating three membership functions of blackness, whiteness, and chromaticness on the NCS color triangle, a target color can be easily obtained as the center of gravity of the output fuzzy set. In the present paper, the differences among crisp achromatic colors, fuzzy achromatic colors, and fuzzy modified achromatic colors (e.g., reddish achromatic colors) are described, and crisp modified achromatic colors are shown to be a result of achromatic colors that have appropriate vagueness.*
Keywords: Fuzzy set theoretical approach, Natural color system (NCS), Achromatic color, Vague color, NCS color triangle, Triangular pyramid membership function, Conical membership function, HLS (hue, lightness, saturation) System

1. **Introduction.** Sivik introduced the Swedish Natural Color System (NCS), which is based on the principles of opponent-process theory [4]. The Munsell (HVC) system, widely used in the US and Japan, is based on lightness (Value), saturation (Chroma), and Hue. The goal in designing this system was to achieve equal perceptual distance within each attribute. Munsell divided the hue circuit into five sectors of twenty steps each, with the resulting principal hue divisions being purple, red, yellow, green, and blue. Estimating the degree of resemblance that a color sample bears to ideal red, yellow, green, blue, black, and white scales the NCS. Estimating its chromaticness, whiteness, and blackness as a percentage, where the total of the three attributes is equivalent to 100%, specifies a sample. There are several important differences between the Munsell system and NCS. NCS is based on direct estimation rather than on comparison with samples, so use of the NCS (rather than an NCS atlas) is independent of lighting conditions. Munsell is open with respect to the saturation dimension, whereas NCS is closed, i.e. NCS chromaticness can be estimated and Munsell Chroma cannot be estimated. Munsell space is based on differences between neighboring colors, NCS is based on the degree of resemblance to elementary colors. With regard to lightness, the Munsell system considers lightness to be fundamental, whereas, in contrast, NCS considers blackness to be fundamental. Two systems represent the psychological space by which people categorize colors.