Posted: 9/10/2024 **Due: 9/16/2024 at 6:00PM**

Question 1: True or False?

Tell whether each of the following statements is true or false by checking the appropriate box. It may be a good idea for you not to check any box if you do not know the correct answer, because you will lose points for incorrect answers (and get zero points if you do not give an answer).

Statement	True	False
a) Saturation is a measure of the overall amount of light within the visible spectrum.	[ ]	[✓]
c) A color with a hue of 120 degrees and saturation and intensity greater than zero looks blue.	[ ]	[✓]
d) In the human retina, the color-sensitive light receptors are called cones.	[✓]	[ ]
i) The focal length of a camera is the distance between its lens and the object to be photographed.	[ ]	[✓]
i) Every RGB color can be converted into a corresponding HSI value.	[✓]	[ ]

Question 2: It's all about HSI

(a) Explain how colors are represented in the HSI color space. What are its dimensions, the range of values in each dimension, and how do changes in these values affect the represented color? Please provide as much detail as you can think of, but do not use any mathematical formulas.

(b) What are the advantages of the HSI color space as compared to the RGB color space for artificial vision systems and for humans? Again, please give as much detail as possible.

(a) In the HSI (Hue, Saturation, Intensity) color space, colors are broken down into three distinct dimensions: Hue, Saturation, and Intensity. Hue describes the type of color and is determined by the dominant wavelength in the spectral distribution of light. For example, red corresponds to longer wavelengths, while blue corresponds to shorter wavelengths. The hue is represented as an angle on the color wheel, where different angles correspond to different colors, such as 0° for red, 120° for green, and 240° for blue.

Saturation refers to the vividness or purity of a color, which is determined by the ratio of light at the dominant wavelength to the total light across all wavelengths. Saturation is measured on a scale from 0 to 1, where 0 represents a completely gray color with no dominant wavelength (fully desaturated), and 1 represents the purest version of the hue (fully saturated). As saturation increases, the color appears more vibrant and intense because most of the light is concentrated at a single wavelength. Decreasing saturation causes the color to become more washed out and gray due to the mixing of light from multiple wavelengths.

Intensity represents the brightness of the color and is a measure of the overall amount of light within the visible spectrum. Intensity affects how light or dark the color appears, and changes in intensity scale the brightness of all wavelengths proportionally. It can be represented on a scale from 0 to 1 (normalized) or 0 to 255 (commonly used in digital imaging). A lower intensity makes the color darker, approaching black, while a higher intensity makes the color lighter, approaching white.

(b) The HSI color space offers several advantages over the RGB model for artificial vision systems and aligns more naturally with human color perception. One of the key benefits is that HSI separates the color information (hue) from brightness (intensity) and vividness (saturation). This separation makes it more intuitive for humans to interpret colors. For example, it's easier to think of a color as "bright green" in terms of hue and intensity rather than deciphering the specific RGB values that represent that color.

For artificial vision systems, the HSI model can improve color segmentation and recognition by isolating color components from brightness. Variations in light intensity primarily affect the intensity channel in HSI, leaving hue and saturation relatively stable under moderate lighting changes. As a result, systems can detect colors more reliably without being significantly affected by brightness variations or shadows, which often cause all three RGB channels to fluctuate.

Additionally, HSI simplifies color manipulation and detection. Systems can focus on the hue component to identify or adjust specific colors, streamlining processes that are more complex in the RGB model due to the interdependence of the RGB values. This capability is beneficial in tasks like object detection and color tracking, where consistent color interpretation is crucial.

HSI is also frequently used in image enhancement and digital media because it allows for independent brightness and contrast adjustments without altering the color information. This flexibility is more challenging to achieve with RGB, where changes in brightness can inadvertently affect the perceived color due to the combined nature of the RGB channels.