To Measure the Perimeter of an Ellipse Using Image Processing and Mathematical Reasoning

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Abstract: Image processing and mathematical reasoning are two powerful techniques to solve some of the complex problems. Since the perimeter of ellipse is not determined accurately as well as the existing perimeter equations are too complex, researchers attempt to find proper solutions for this issue. This paper proposes a novel approach to measure the perimeter of an ellipse by using image processing and mathematical reasoning. This approach consists of two stages. In the first stage, value of a pixel is calculated via a pixel-by-pixel image processing based on the perimeter of several circles having different radii. In the second stage, the perimeter of an ellipse is defined by the pixels of various ellipses having different diameters and the value of a pixel through a mathematical reasoning. Simulation results show that $P = 1.14167\pi (a + b)$ is the suggested perimeter of an ellipse according to the considered simulation scenarios.

Keywords: Perimeter of an Ellipse, Image Processing, Mathematical Reasoning, Simulation.

1. Introduction

A 2D continuous digital image $a[x, y]$ is composed of $m$ rows and $n$ columns where $x = \{1, 2, ..., m\}$ and $y = \{1, 2, ..., n\}$. RGB and CMYK are two main color spaces that indicate each pixel of a digital image. RGB pixel is mixed by the red, green, and blue colors. In contrast, CMYK pixel is mixed by the cyan, magenta, yellow, and black colors. Image processing studies any procedure that takes an image as input and returns an image as output. It has various applications in mathematics, biology, biometrics, etc. Some of the mathematical techniques can use a pixel-by-pixel image processing to gather graphical information of the digital images [1-5].

Mathematical reasoning is a powerful tool to evaluate various patterns for selecting some appropriate problem-solving strategies. It can analyze some of the mathematical situations to construct logical arguments. Mathematical reasoning is conducted via four aspects: patterns with explanation, definitions & accurate, covering all cases, and correcting the sequence of results. This type of reasoning uses different thinking skills to carry out the efficient strategies. Thinking skills can be used in thinking processes such as comparing, identifying patterns & relationships, and induction. Pattern with explanation reasoning uses several patterns to conclude a formula for the prediction and validation processes [6, 7].

The perimeter of ellipse is not defined accurately. Therefore, researchers have attempted to find a proper solution for this issue already. In this paper, a new approach is proposed to define the perimeter of an ellipse. It uses value of a pixel based on a pixel-by-pixel image processing through a pattern-based mathematical reasoning. This approach is simulated under various simulation scenarios to define a general formula for the perimeter of an ellipse.

The remainder of the paper is organized as follows. Section 2 represents a problem definition for the perimeter of ellipse. Section 3 describes the proposed approach based on image processing and mathematical reasoning. Section 4 illustrates simulation results under various simulation scenarios. Finally, the paper is concluded by Section 5.

2. Problem Definition

Fig. 1 shows an overall schematic of the ellipse. In this schema, $a$ is the largest diameter and $b$ is the smallest diameter. Since $a$ and $b$ are measured from the center, they are called the radius measures too.