

Spinning Image Generation in Polar Coordinate System

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Abstract

In this paper, a spinning effect is studied and applied in existing imageset. Some examples of spinning effect are provided and their assessed performance results are shown in visual and objective performance metric. It is found that applied spinning effect in original images could cause unwanted artifacts. However, basically spinning operation is reversible operation. Two parameters, θ and ρ , are used for the system, and these parameters are transformed into polar coordinate, and final θ and ρ values are obtained by processing D and K parameters. After spinning operation, pixels in polar coordinate are re-transformed into Cartesian coordinate. Simulation results section provides performance comparison and discovered results.

Keywords: *Spinning effect, image processing, image enhancement, transform, revisable coming, metric*

1. Introduction

Image and video are represented as a matrix or an array, which is generally structured as square formed pixel sets ordered in columns and rows [1-2]. For instance, in grayscale image, each pixel is organized with eight bit symbol, and its corresponding intensity value is [0,255]. Here, intensities 0 and 255 indicate black and white pixels, respectively. If the number of channels is more than three, images are called as color images [3-5].

There have been different color image formats such as Graphics Interchange Format (GIF), Joint Photographic Experts Group (JPEG), Tagged Image File Format (TIFF), Postscript (PS) or PSD. The GIF format is a non-ruinous compressed bitmap format, mainly used for the web information. The JPEG founds to be effective for its discrete cosine transform characteristics, and due to quantization process it could destroy image quality. However, JPEG's rate vs. distortion is quite high, which allows JPEG to be widely used. On the other hand PS or PSD are standard vector formats.

Image filters can change digitally obtained input signal and users of devices (computers, scanner, or digital cameras) can give different image effects [6,7]. In this paper, we study spinning effect and its application in general images, which makes original image swirled. The spinning effect is widely added. Two examples of spinning operation is shown in Figure 1, where two typical spinning effects are displayed.

This paper is arranged as follows. Section 2 explains presented spinning operation in detail. Section 3 shows simulation results and its corresponding discussions. Finally, conclusion remarks are provided in Section 4.



Figure 1. Two Examples of Spinning Effect [8-9]

2. Proposed Spinning Operation

In this stage, one applies and implements rotation and spinning filters [10]. The characteristics of these filters are determined by parameters, and these are noted as θ and ρ with initial state. The spinning operation is employed to hide or process particular scene in an image or video frame. During the transfer of original image information, it can be lost or perfectly reconstructed depend on the amount of spinning effect. In general, spinning operation is known as reversible by implementing identical operation with opposite amount of anti-spinning operation. However, when initial spinning operation is not informed, the reproduction process cannot be fulfilled. There are two key parameters, θ and ρ , which determine the amount of spinning operation in an image.

The block diagram of the proposed method is shown in Figure 2, where three parameter selection processes exist. These determined parameters are m , K , and D . The proposed spinning operation is conducted as follows.

2.1. Coordinate Processing and Transform

In Cartesian coordinate, parameters x and y are transformed to ρ and θ . Here, parameters ρ and θ are represented by polar coordinate. The polar coordinate system (CS) is a 2D CS where each pixel on a plane is settled by a distance from a pre-determined pixel and an angle from a certain direction. The certain pixel is noted as a pole, and the beam from the center in the certain guidance is the polar axis. Therefore, we assume the distance from the pole as the radius, and the angle is angular coordinate.

In the proposed method, we determine parameters K_1, K_2, \dots, K_m which divide parameters $\theta_1, \theta_2, \dots, \theta_m$, and then we obtain result set Θ . For parameter ρ , we determine parameters D_1, D_2, \dots, D_m , which divide parameters $\rho_1, \rho_2, \dots, \rho_m$ to obtain result set P .

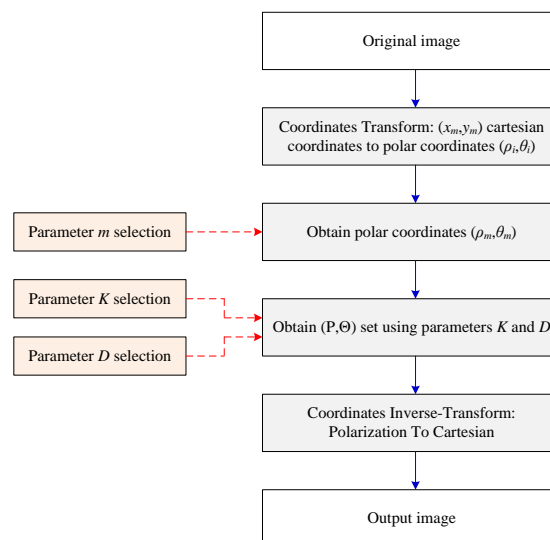


Figure 2. Flowchart of the Proposed Method

During above processes, distortions are applied and contaminated images are obtained. In equations, above processes can be described as

$$\rho_m = (x_m^2 + y_m^2)^{1/2}, \quad (1)$$

$$\tan(\theta_m) = y_m / x_m, \quad (2)$$

where m is integer number and n stands for n^{th} parameter sets. Parameters P and Θ are newly obtained in the polar coordinate. During this process, we use trigonometric functions *sine* and *cosine* functions to find P_n and Θ_n . In general, the range of θ is $(-\pi, \pi]$, and θ_m can be obtained from x and y as follows:

$$\theta_m = \begin{cases} \arctan(y_m / x_m), & \text{for } x_m > 0, \\ \arctan(y_m / x_m) + \pi, & \text{for } x_m < 0 \ \& \ y_m \geq 0, \\ \arctan(y_m / x_m) - \pi, & \text{for } x_m < 0 \ \& \ y_m < 0, \\ \pi / 2, & \text{for } x_m = 0 \ \& \ y_m \geq 0, \\ -\pi / 2, & \text{for } x_m = 0 \ \& \ y_m < 0, \\ \text{undefined}, & \text{otherwise.} \end{cases} \quad (3)$$

Then, P_n and Θ_n can be calculated as

$$P_n = \frac{\sum_{m=1}^n \rho_m}{m \cdot D_n} \quad (4)$$

$$\Theta_n = \frac{\sum_{m=1}^n \theta_m}{m \cdot K_n} \quad (5)$$

Figure 3 depicts an example of Eqs. (1,2) and Eqs. (4,5).

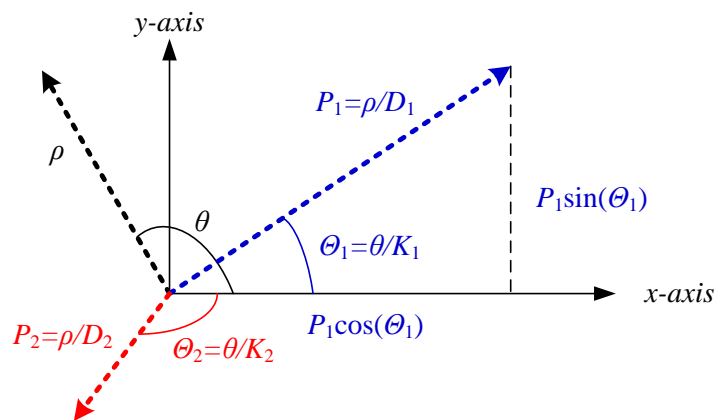


Figure 3. Example of Cartesian to Polar Coordinate Conversion; Original θ and ρ are Transformed to Θ and P , Respectively

2.2. Reconstruction

To reconstruct original images, we apply anti-spinning operation filter. This process is the opposite process of described spinning operation filter. Figure 4 shows result images with different parameter sets. Employed image is Zahra dataset #6 image. The original image is shown in Figure. 4(a). We assume initial condition of K is given as 1. Then, we changed parameter D with different values such as 10, 20, 50, 100, 200, 400, 800, and 1600. As one can see, as parameter D decreases, images are less similar to the original image. The reason is that the parameter ρ is divided by parameter D .

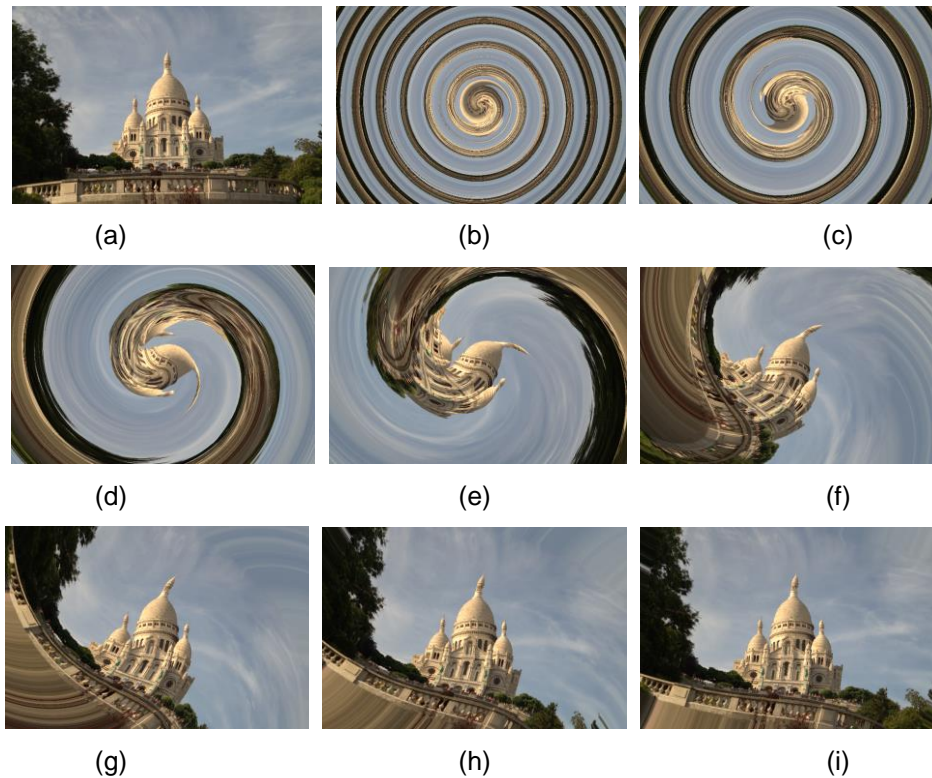


Figure 4. Image #6 of Zahra Dataset with $K=1$: (a) Original Image, (b) $D=10$, (c) $D=20$, (d) $D=50$, (e) $D=100$, (f) $D=200$, (g) $D=400$, (h) $D=800$, and (i) $D=1600$

3. Experimental Results

Simultoin reesults are provided in this section. The objective and subjective performance comaprison is displayed. We employed a dataset of 25 color images, all imaes were captured using a two-shot approach. The imaege are named as Zahra imageset [add] for its simplicity. The size of all images are 768x512. The presented method is tested on Zahra imageset which is shown in Figure 5.

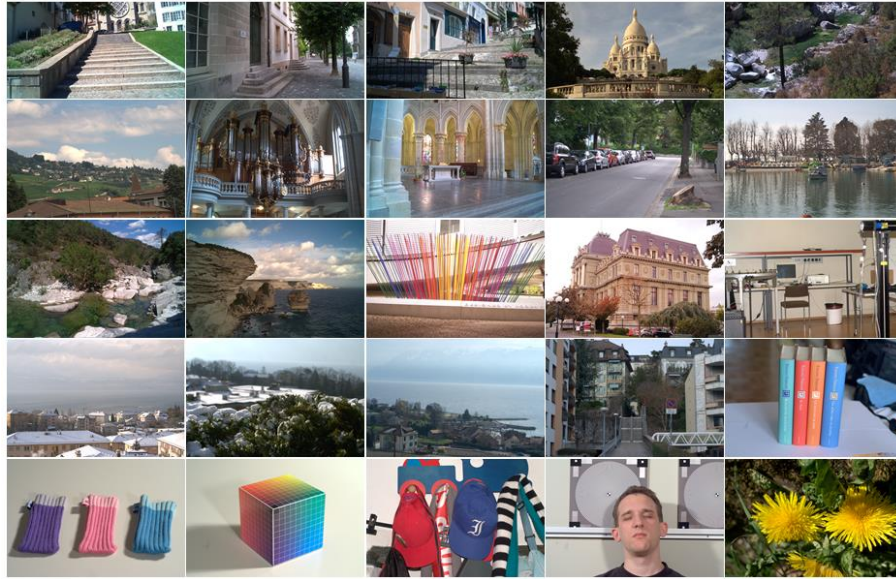


Figure 5. Tested Dataset for the Proposed Method

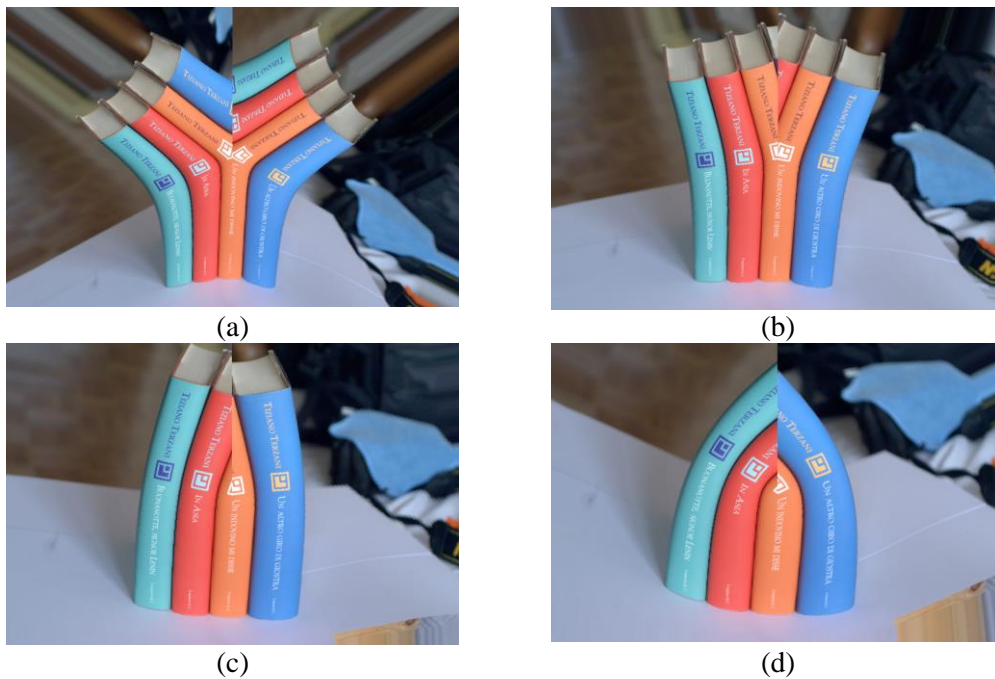


Figure 6. Conducted Simulation Results Images on Image #20 with D=1: (a) K=0.7, (b) K=0.9, (c) K=1.1, and (d) K=1.3

The metric we adopted is mean squared error (MSE), which is applied on each color channel: red, green, blue, and color image. The MSE equation to assess reconstructed images is.

$$MSE = \frac{1}{H \times V} \sum_{v=1}^V \sum_{h=1}^H (Y_{(h,v)} - \hat{Y}_{(h,v)})^2 \quad (6)$$

where $Y_{(h,v)}$ is pixel intensity at (h,v) position. The hat of $Y_{(h,v)}$ is the reconstructed image at (h,v) position. Figures 6 and 7 displays result images with different parameter

sets. We used two image, #20 and #22, and tested different K values while $D=1$ condition. The used K values are 0.7, 0.9, 1.1, and 1.3.

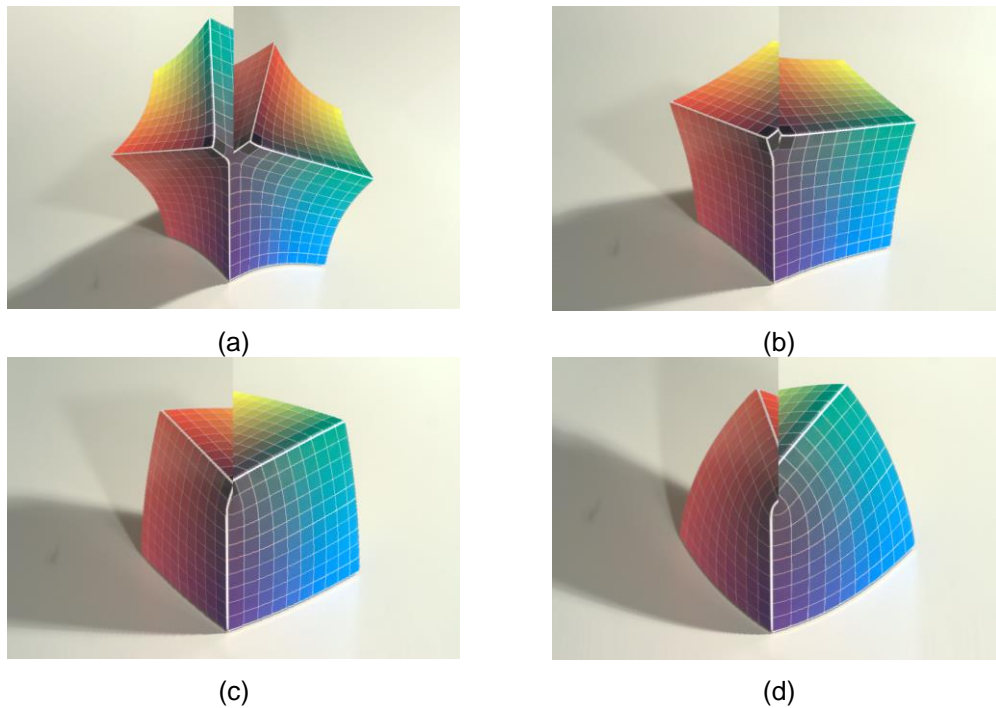


Figure 7. Conducted Simulation Results Images on Image #22 with $D=1$: (a) $K=0.7$, (b) $K=0.9$, (c) $K=1.1$, and (d) $K=1.3$

Figure 8 shows MSE comparison results in graph. Parameter D is 1.0, while K values are different such as $K=0.7$, $K=0.9$, $K=1.1$, and $K=1.3$. There are four figures in Fig. 8, and each graph shows red, green, blue and color image results.

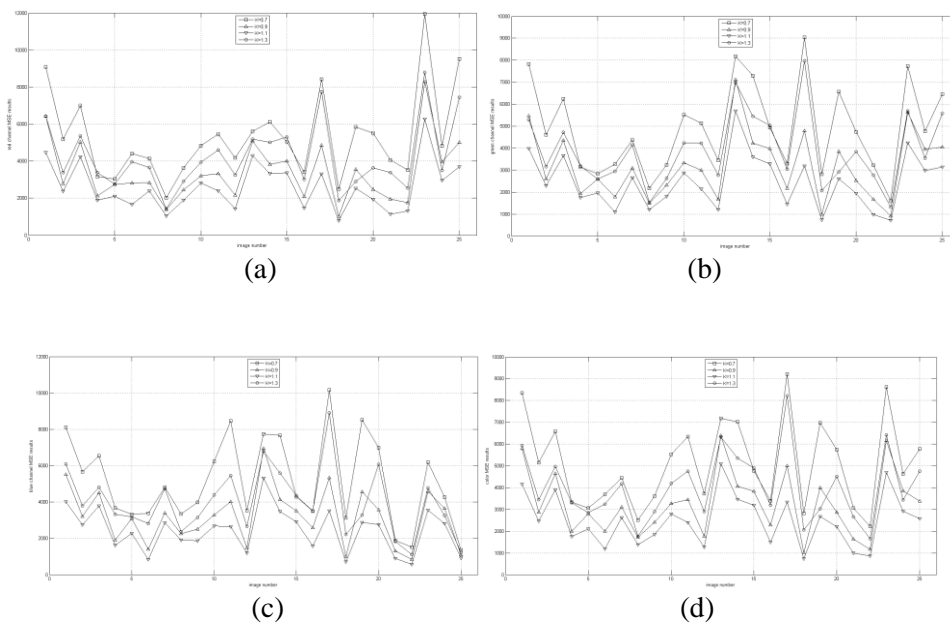


Figure 8. Mean Squared Error Comparison with Determined $D=1.0$ and Different K : (a) Red Channel, (b) Green Channel, (c) Blue Channel, and (d) Color MSE

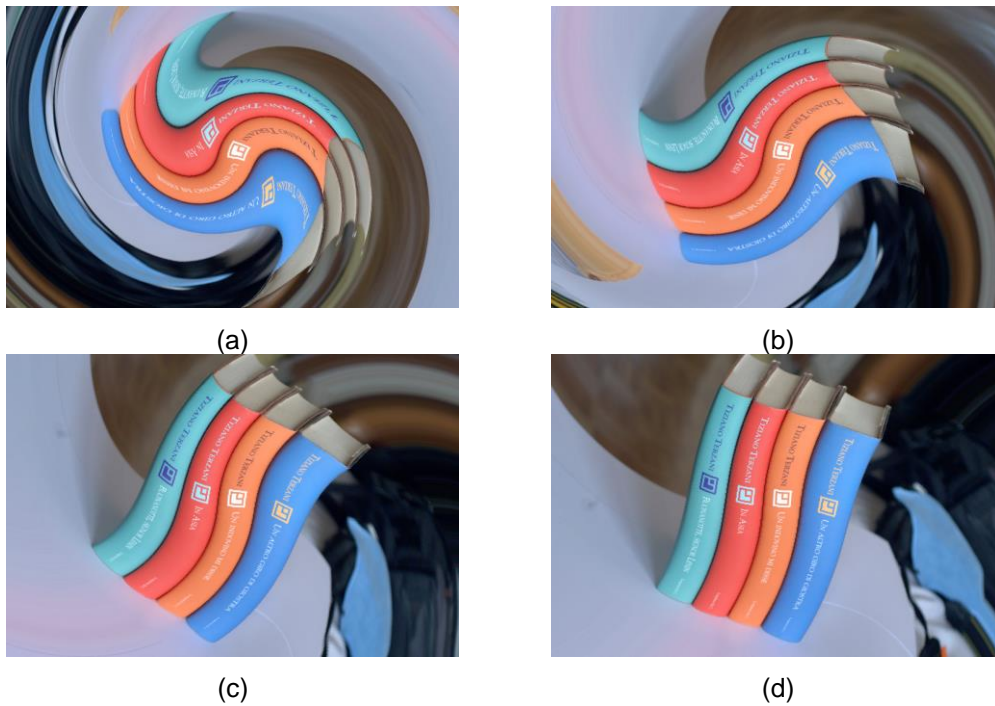


Figure 9. Conducted Simulation Results Images on Image #20 with K=1: (a) D=100, (b) K=200, (c) K=400, and (d) K=800

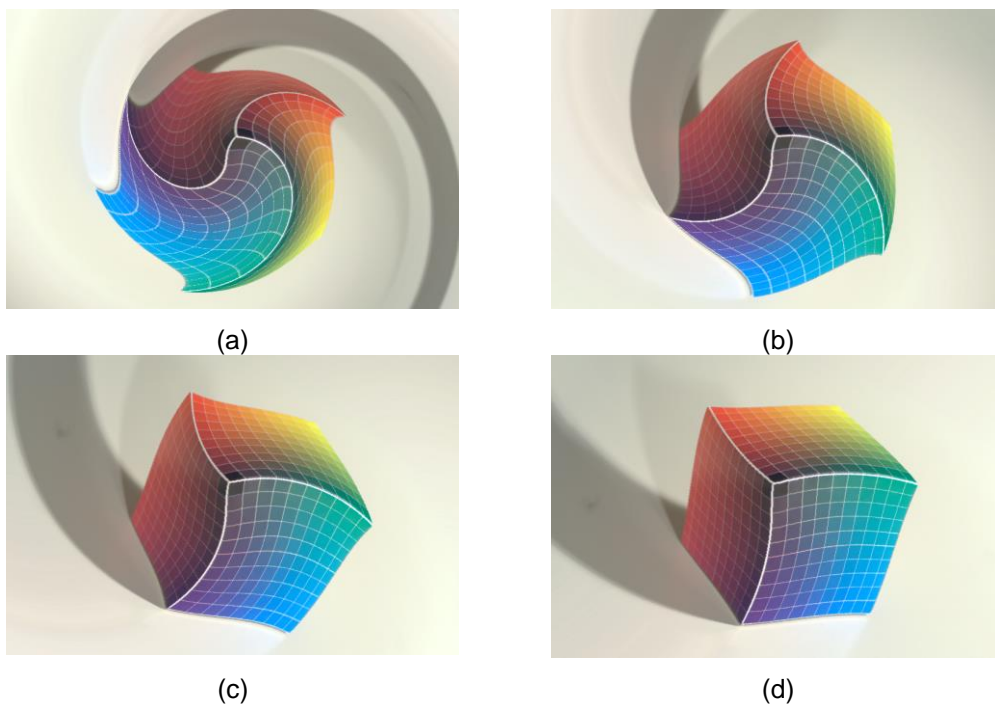


Figure 10. Conducted Simulation Results Images on Image #22 with K=1: (a) D=100, (b) K=200, (c) K=400, and (d) K=800

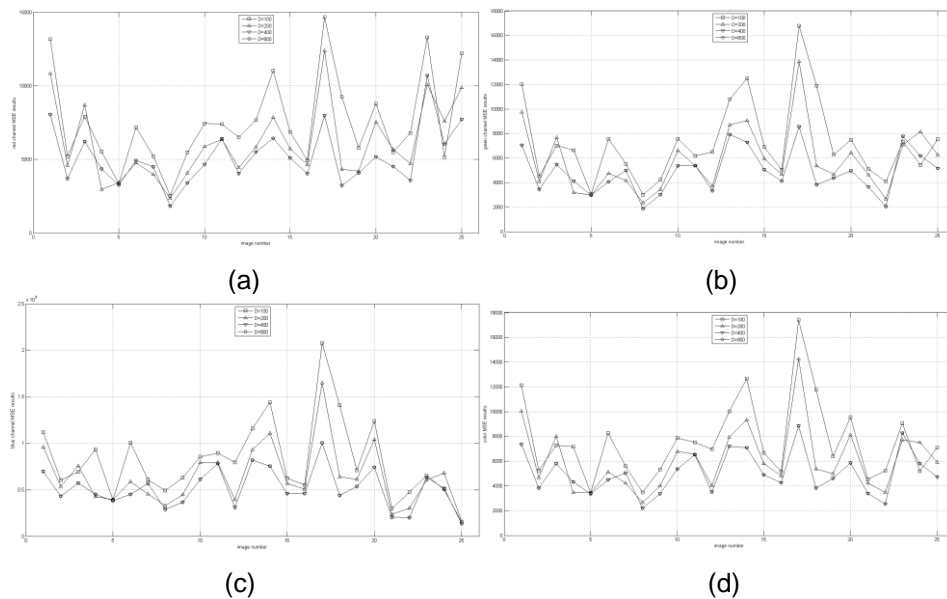


Figure 11. Mean Squared Error Comparison with Determined $K=1.0$ and Different D : (a) Red Channel, (b) Green Channel, (c) Blue Channel, and (d) Color MSE

Another scenario is that we can give $K=1$ and evaluate performance with different D values. Normally D value is quite bigger than typical K value. The used D is 100, 200, 400, and 800. Figures 9 and 10 show subjective performance results on #20 and #22 images. Objective performance comparison with MSE metric is shown in Figure 11. As we can see, red, green, blue, and color image performance are provided.

4. Conclusions

This paper explains how to generate and manage spinning effect in existing imageset. The proposed spinning effect is operated by θ and ρ parameters, and D and K parameters support yet another effect. Experimental results were shown with figures, which give objective and visual performance comparison.

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