An Adjustable Interpolation-based Data Hiding Algorithm Based on LSB Substitution and Histogram Shifting

Yuan-Yu Tsai, Department of M-Commerce and Multimedia Applications, Asia University and Department of Medical Research, China Medical University Hospital, Taichung, Taiwan
Yao-Hsien Huang, Department of Information Technology and Management, Shih Chien University, Taipei, Taiwan
Ruo-Jhu Lin, Department of M-Commerce and Multimedia Applications, Asia University, Taichung, Taiwan
Chi-Shiang Chan, Department of M-Commerce and Multimedia Applications, Asia University and Department of Medical Research, China Medical University Hospital, Taichung, Taiwan

ABSTRACT

Data hiding can be regarded as a type of image processing techniques. Other image processing operations are usually integrated to increase the embedding capacity or decrease the visual distortion. Interpolation is an example of this type of operation. However, previous interpolation-based data hiding algorithms suffered from low and fixed embedding capacity and high visual distortion. This study proposes a more effective two-stage data hiding algorithm based on interpolation, LSB substitution, and histogram shifting. First, the authors modify the formula for embedding capacity calculation and make some adjustments on the sample pixels determination. A threshold is used to obtain the block complexity and each embeddable pixel has a different amount of message embedded. Second, an LSB substitution method and an optimal pixel adjustment process are adopted to raise the image quality. Finally, the authors’ proposed algorithm can support adjustable embedding capacity. Compared to the previous algorithm, the experimental results demonstrate the feasibility of the proposed method.

KEYWORDS

Data Hiding, Histogram Shifting, Image Interpolation, LSB Substitution, Optimal Pixel Adjustment Process

INTRODUCTION

Interpolation is a common multimedia processing technique. The main concept of interpolation is to use known discrete data to estimate the value at an unknown position. The familiar interpolation techniques include nearest-neighbor interpolation, linear interpolation, and bilinear interpolation. The nearest-neighbor interpolation is the simplest method that selects the value of the nearest point as the predicted value for the unknown position, not considering the values of other neighboring points. For example in Figure 1, each point is characterized by $x$ coordinate value, $y$ coordinate value, and its corresponding value $V$. Assume $P_A$ and $P_B$ are known points with corresponding value $V_A$ and $V_B$. The predicted value $V_E$ for point $P_E$ equals $V_A$ because point $P_A$ is closer to $P_E$ than other points. However, the nearest-neighbor interpolation causes undesirable jagged interpolation results. Another simple interpolation method is called linear interpolation, and it is determined by searching the closest two neighboring points and interpolating the predicted value with the concept of similar triangle. For example in Figure 1, the value $V_E$ of point $P_E$ can be interpolated using Equation 1.
Finally, bilinear interpolation is an extension of linear interpolation for two variables on a regular 2D grid. For interpolating the point on a 2D grid, linear interpolation is performed three times to interpolate one unknown point on a 2D grid (See Equations 2 and 3).

\[
V_E = \frac{x_B - x_E}{x_B - x_A} V_A + \frac{x_E - x_A}{x_B - x_A} V_B \\
V_E = \frac{x_B - x_E}{x_B - x_A} V_A + \frac{x_E - x_A}{x_B - x_A} V_B, \quad V_F = \frac{x_D - x_F}{x_D - x_C} V_C + \frac{x_F - x_C}{x_D - x_C} V_D \\
V_G = \frac{y_G - y_F}{y_E - y_F} V_E + \frac{y_E - y_G}{y_E - y_F} V_F
\]
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