International Research Journal of Education and Technology

Peer Reviewed Journal

ISSN 2581-7795

Comparative Study of Image Interpolation Methods

Shahi. D[1], Mary Synthuja Jain Preetha. M[2], Vijula Grace. K. S[3], Vinod Kumar. R. S[4]

[1]*Assistant Professor*, [2]*Associate Professor*, [3]*Associate Professor*, [4]*Professor*,
Department of Electronics and Communication Engineering
Noorul Islam Centre for Higher Education, Kumaracoil, Tamil Nadu, India

***Abstract*— Image interpolation method is used to process the image where increase in size of the given image is done by a scaling factor. The method of image interpolation is used in medical imaging field, digital photographic filed, film scanning media etc. Attaining reversibility is an important need in data hiding field which is attained using the image interpolation technique. Image interpolation is also used in the reconstruction of Computer Tomography (CT) images and Magnetic Resonance Images (MRI). The need of image interpolation is low processing speed and good visual quality.**

***Keywords*—** Reversibility, Image Interpolation, Neighbor Mean Interpolation, Interpolation by Neighboring Pixels

I. INTRODUCTION

A new branch of data hiding is steganography using image interpolation [6]. Here the input image of size $m \times n$ is increased by a size of $2m \times 2n$. The popular image interpolation techniques are

- Nearest Neighbor Interpolation (NNI)
- Neighbor Mean Interpolation (NMI)
- Interpolation by Neighboring Pixels (INP)
- Interpolation by Maximizing the difference values between Neighboring Pixels (IMNP)
- High Capacity Reversible Steganography using multilayer embedding (CRS)
- Modified Neighbor Mean Interpolation (MNMI)
- Reversible and Adaptive Steganographic (RAS) method of Interpolation.

The detailed explanation of some of the image interpolation techniques are discussed in the following sections.

II. NEIGHBOR MEAN INTERPOLATION (NMI)

The unknown pixel values are calculated by taking the average value of the surrounding pixels [4].

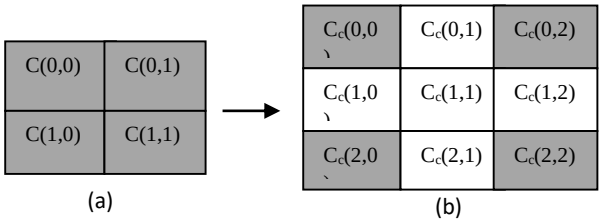

Fig. 1 Example of NMI (a) Original Image (b) Enlarged Image

Consider a original image of size 2×2 which interpolated to a size of 3×3 as shown in Figure 1.

The mathematical representation for NMI is given in Equation 1.

$$\left.\begin{aligned} C_c(0,0) &= C(0,0) \\ C_c(0,2) &= C(0,1) \\ C_c(2,0) &= C(1,0) \\ C_c(2,2) &= C(1,1) \\ C_c(0,1) &= \frac{C_c(0,0)+C_c(0,2)}{2} \\ C_c(1,0) &= \frac{C_c(0,0)+C_c(2,0)}{2} \\ C_c(2,2) &= \frac{C_c(0,0)+C_c(0,1)+c_c(1,0)}{3} \end{aligned}\right\} \quad (1)$$

III. INTERPOLATION BY NEIGHBORING PIXELS (INP)

This type of interpolation is based on the concept that the neighboring pixels have almost similar values [4]. The mathematical representation for INP is given in Equation 2.

$$\left.\begin{aligned} C_c(0,0) &= C(0,0) \\ C_c(0,2) &= C(0,1) \\ C_c(2,0) &= C(1,0) \\ C_c(2,2) &= C(1,1) \\ C_c(0,1) &= \frac{C_c(0,0)+\frac{C_c(0,0)+C_c(0,2)}{2}}{2} \\ C_c(1,0) &= \frac{C_c(0,0)+\frac{C_c(0,0)+C_c(2,0)}{2}}{2} \\ C_c(1,1) &= \frac{C_c(0,1)+C_c(1,0)}{2} \end{aligned}\right\} \quad (2)$$

IV INTERPOLATION BY MAXIMIZING THE DIFFERENCE BETWEEN PIXELS (IMDP)

International Conference on Electrical Electronics & Communication Technology (ICEECT'24) ISBN: 978-93-340- 6066-9, PERI INSTITUTE OF TECHNOLOGY, Chennai. © 2024, IRJEdT Volume: 06 Issue: 05 | May -2024

International Research Journal of Education and Technology

Peer Reviewed Journal

ISSN 2581-7795

This type of interpolation is based on the property similar values of the neighboring pixels [3]. The mathematical representation for the IMDP technique is given in Equation 3.

$$\left.\begin{aligned} C_{max} &= \max(C_c(0,0),\ C_c(0,2),\ C_c(2,0),\ C_c(2,2,)\\ C_C(0,0) &= C(0,0)\\ C_c(0,2) &= C(0,1)\\ C_c(2,0) &= C(1,0)\\ C_c(2,2) &= C(1,1)\\ C_c(0,1) &= \frac{C_{max}+\frac{C_c(0,0)+C_c(0,2)}{2}}{2}\\ C_c(1,0) &= \frac{C_{max}+\frac{C_c(0,0)+C_c(2,0)}{2}}{2}\\ C_c(1,1) &= \frac{C_c(0,1)+C_c(1,0)}{2} \end{aligned}\right\} \quad (3)$$

V High Capacity Reversible Steganography using Multilayer Embedding (CRS)

This type of interpolation is based on the concept of identical characteristics of difference in pixel values of the surrunding pixels [1].

The mathematical representation for the CRS technique is indicated in Equation 4.

$$\left.\begin{aligned} C_{max} &= \max(C_c(0,0),\ C_c(0,2),\ C_c(2,0),\ C_c(2,2,)\\ C_{min} &= \min(C_c(0,0),\ C_c(0,2),\ C_c(2,0),\ C_c(2,2,)\\ A &= \frac{(3\times C_{min})+C_{max}}{4}\\ C_C(0,0) &= C(0,0)\\ C_c(0,2) &= C(0,1)\\ C_c(2,0) &= C(1,0)\\ C_c(2,2) &= C(1,1)\\ C_c(0,1) &= \frac{A+\frac{C_c(0,0)+C_c(0,2)}{2}}{2}\\ C_c(1,0) &= \frac{A+\frac{C_c(0,0)+C_c(2,0)}{2}}{2}\\ C_c(1,1) &= \frac{C_c(0,0)+C_c(0,1)+C_c(1,0)}{3} \end{aligned}\right\} \quad (4)$$

VI Modified Neighbor Mean Interpolation (MNMI)

This type of interpolation is based on the concept that the surrounding pixels have high effects on a particular pixel value [2].

The mathematical representation for MNMI is given in Equation 5.

$$\left.\begin{aligned} C_C(0,0) &= C(0,0)\\ C_c(0,2) &= C(0,1)\\ C_c(2,0) &= C(1,0)\\ C_c(2,2) &= C(1,1)\\ C_c(1,1) &= \frac{C_c(0,0)+C_c(0,2)+C_c(2,0)+C_c(2,2)}{4}\\ C_c(0,1) &= \frac{2\times C_c(0,0)+2\times C_c(0,2)+C_c(1,1)}{5}\\ C_c(1,0) &= \frac{2\times C_c(0,0)+2\times C_c(2,0)+C_c(1,1)}{5} \end{aligned}\right\} \quad (5)$$

VII Reversible and Adaptive Steganographic (RAS) method of Interpolation.

This type of interpolation is based on the identical properties of surrounding pixels to calculate the unknown pixel value. The mathematical representation of RAS technique is given in Equation 6.

$$\left.\begin{aligned} C_C(0,0) &= C(0,0)\\ C_c(0,2) &= C(0,1)\\ C_c(2,0) &= C(1,0)\\ C_c(2,2) &= C(1,1)\\ C_c(0,1) &= \frac{C_c(0,0)+\frac{C_c(0,0)+C_c(0,2)}{2}}{2}\\ C_c(1,0) &= \frac{C_c(0,0)+\frac{C_c(0,0)+C_c(2,0)}{2}}{2}\\ C_c(1,1) &= \frac{C_c(0,0)+\frac{C_c(0,1)+C_c(1,0)}{2}}{2} \end{aligned}\right\} \quad (6)$$

VIII Experimental Analysis

The performance of the various interpolation techniques were analyzed with the help of Peak Signal to Noise Ratio (PSNR), Surface Similarity Index Measure (SSIM) and execution time. The comparison of PSNR of various interpolation methods are given in Table 1.

TABLE I
Comparative table of PSNR of various interpolation methods

Images	NMI	INP	IMNP	CRS	MNMI	RAS
Airplane	22.21	22.53	21.11	21.58	21.79	22.50
Barbara	24.40	24.83	22.94	23.64	23.87	24.77
Bridge	23.06	23.42	21.83	22.32	22.54	23.40
Flower	28.51	29.38	25.72	27.03	27.48	29.24
Lina	24.85	25.31	23.57	24.00	24.30	25.25
Lion	21.63	21.89	20.87	21.23	21.31	21.89
Tiger	23.05	23.53	21.27	22.16	22.41	23.49

Sea	22.73	23.05	21.80	22.26	22.32	23.04
Ship	23.67	24.05	22.46	23.03	23.19	24.03
Goldhill	26.35	26.78	25.03	25.56	25.80	26.74

The comparison of SSIM of various interpolation methods are given in Table 2.

TABLE III
COMPARATIVE TABLE OF SSIM OF VARIOUS INTERPOLATION METHODS

Images	NMI	INP	IMNP	CRS	MNMI	RAS
Airplane	0.8250	0.8412	0.7831	0.7942	0.8041	0.8408
Barbara	0.7577	0.7747	0.7060	0.7263	0.7381	0.7729
Bridge	0.6672	0.6942	0.6041	0.6221	0.6308	0.6950
Flower	0.8808	0.8965	0.8306	0.8498	0.8620	0.8943
Lina	0.8331	0.8514	0.7861	0.8026	0.8133	0.8496
Lion	0.5888	0.6170	0.5306	0.5488	0.5533	0.6192
Tiger	0.8318	0.8488	0.7724	0.8017	0.8072	0.8490
Sea	0.7253	0.7464	0.6777	0.6945	0.6965	0.7476
Ship	0.7479	0.7703	0.6925	0.7131	0.7192	0.7704
Goldhill	0.7807	0.8008	0.7283	0.7433	0.7534	0.8005

The comparison of Execution time of various interpolation methods are given in Table 3.

TABLE IIIII
PERFORMANCE COMPARISON OF EXECUTION TIME OF VARIOUS INTERPOLATION METHODS

Images	NMI	INP	IMNP	CRS	MNMI	RAS
Airplane	3.04	4.38	3.62	3.75	4.17	4.56
Barbara	3.56	3.48	4.04	3.69	3.83	4.37
Bridge	3.07	3.28	3.34	3.94	4.11	3.59
Flower	3.24	3.38	3.45	3.07	3.37	3.34
Lina	3.54	3.40	3.02	3.78	3.68	4.38
Lion	3.19	3.65	3.31	3.04	3.56	4.16
Tiger	3.29	3.40	3.92	3.68	3.81	4.05
Sea	2.99	3.43	3.39	3.20	3.30	4.37
Ship	3.20	3.63	3.29	3.00	3.50	4.11
Goldhill	3.11	3.32	3.46	3.67	10.29	3.83

IX CONCLUSION

On comparing the PSNR and SSIM, the Reversible and Adaptive Steganographic (RAS) method of Interpolation gave better results over the other methods. Another best method of interpolation is High Capacity Reversible Steganography using multilayer embedding (CRS). The execution time is less for Neighbor Mean Interpolation (NMI) method. But the PSNR and SSIM are lesser than other methods.

REFERENCES

[1] Tang, M., Hu, J., & Song, W. (2014). A high capacity image steganography using multi-layer embedding. *Optik*, *125*(15), 3972-3976.
[2] Malik, A., Sikka, G., & Verma, H. K. (2017). Image interpolation based high capacity reversible data hiding scheme. *Multimedia Tools and Applications*, *76*(22), 24107-24123.
[3] Hu, J., & Li, T. (2015). Reversible steganography using extended image interpolation technique. *Computers & Electrical Engineering*, *46*, 447-455.
[4] Lee, C. F., & Huang, Y. L. (2012). An efficient image interpolation increasing payload in reversible data hiding. *Expert systems with applications*, *39*(8), 6712-6719.
[5] Tang, M., Hu, J., Song, W., & Zeng, S. (2015). Reversible and adaptive image steganographic method. *AEU-International Journal of Electronics and Communications*, *69*(12), 1745-1754
[6] Mohammad, A. A., Al-Haj, A., & Farfoura, M. (2019). An improved capacity data hiding technique based on image interpolation. *Multimedia Tools and Applications*, *78*(6), 7181-7205.