COMPARISON OF SUB-SAMPLING ALGORITHM FOR LRIT IMAGE GENERATION

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ABSTRACT: The COMS provides the LRIT/HRIT services to users. The COMS LRIT/HRIT broadcast service should satisfy the 15 minutes timeliness requirement. The requirement is important and critical enough to impact overall performance of the LHGS. HRIT image data is acquired from INRSM output receiving but LRIT image data is generated by sub-sampling HRIT image data in the LHGS. Specially, since LRIT is acquired from sub-sampled HRIT image data, LRIT processing spent more time. Besides, some of data loss for LRIT occurs since LRIT is compressed by lossy JPEG. Therefore, algorithm with the fastest processing speed and simplicity to be implemented should be selected to satisfy the requirement. Investigated sub-sampling algorithm for the LHGS were nearest neighbour algorithm, bilinear algorithm and bicubic algorithm. Nearest neighbour algorithm is selected for COMS LHGS considering the speed, simplicity and anti-aliasing corresponding to the guideline of user (KMA: Korea Meteorological Administration) to maintain the most cloud itself information in a view of meteorology. But the nearest neighbour algorithm is known as the worst performance. Therefore, it is studied in this paper that the selection of nearest neighbour algorithm for the LHGS is reasonable. First of all, characteristic of 3 sub-sampling algorithms is studied and compared. Then, several sub-sampling algorithm were applied to MTSAT-1R image data corresponding to COMS HRIT. Also, resized image was acquired from sub-sampled image with the identical sub-sampling algorithms applied to sub-sampling from HRIT to LRIT. And the difference between original image and resized image is compared. Besides, PSNR and MSE are calculated for each algorithm. This paper shows that it is appropriate to select nearest neighbour algorithm for COMS LHGS since sub-sampled image by nearest neighbour algorithm is little difference with that of other algorithms in quality performance from PSNR.

KEY WORDS: COMS, LRIT, HRIT, LHGS Sub-sampling, Interpolation

1. INTRODUCTION

The COMS (Communication, Ocean, and Meteorological Satellite) to be launched in year 2009 will be the first Korean multi-purpose geostationary satellite aiming at service for LRIT/HRIT (Low Rate Information Transmission/ High Rate Information Transmission). HRIT image data will be generated by the LHGS using MI Level 1B block from the INRSM (Image Navigation and Registration Software Module) of the IMPS (Image Processing Subsystem). As a while, LRIT image data will be serviced by the LHGS using 1/5 sub-sampling for HRIT image data. Specially, since LRIT is acquired from sub-sampled HRIT image data, LRIT processing spent more time. Besides, some of data loss for LRIT occurs since LRIT is compressed by lossy JPEG. Therefore, algorithm with the fastest processing speed and simplicity to be implemented should be selected to satisfy the requirement.

Size of HRIT image data is 11000 pixels (width) X 11000 pixels (height). Since LRIT image data is acquired from sub-sampling of HRIT image data is 2200 pixels (width) X 2200 pixels (height).

Image sub-sampling means that image is reduced in this paper. Because data loss occur in reduced image, the selection for proper sub-sampling algorithm is important. In this paper, some sub-sampling algorithm are studied and applied to MTSAT-1R data corresponding to LRIT/HRIT image data of COMS.

The objective of this paper is to verify selected nearest neighbour algorithm is appropriate for LHGS under development and little difference in quality performance when the nearest neighbour algorithm is compared other algorithms. And the PSNR value acquired by simulation in this paper can be used as a reference for test value after LHGS development will be ended.

2. MAINBODY OF TEXT

Sub-sampling means the image resize. Image resize is image enlargement or reducing image. In this paper, reducing image is studied. If original image is reduced, reduced image is lower resolution image.

For example, if width and height of original image are separately reduced in 1/2 size, information for 4 pixel is changed to information for one pixel.

Besides, image by complicated algorithm has high quality but running time is long. There are a number of techniques one might use to reduce an image. These generally have a trade-off between speed and the degree to which they reduce visual artefacts. Therefore, it is necessary to select proper sub-sampling algorithm for use.

Sub-sampling processing is performed by interpolation. Interpolation is the problem of approximating the value for a non-given point in some space, when given some values of points around that point.

2.1 BACKGROUND KNOWLEDGE

This section will introduce some sub-sampling algorithm.

2.2 Nearest Neighbour

The nearest neighbor algorithm simply selects the value of the nearest point, and does not consider the values of other neighboring points at all. The concept of the nearest neighbor interpolation is that the nearest neighborhood pixel value is allocated to pixel to be displayed. That is, the nearest neighbor interpolation is using nearest neighbor pixel.

The nearest neighbor interpolation is the fastest option. However, it is also the least sophisticated. If image is reduced by the nearest neighbor algorithm, image is changed a great deal for original image. Besides, because pixel value is not newly calculated and pixel information should be acquired from only input pixel, probability for existence of error is large. And the nearest neighbor interpolation does not create an anti-aliasing effect. This leads to problems with jaggies.

2.3 Bilinear

In mathematics, the bilinear interpolation is an extension of the linear interpolation for interpolating functions of two variables on a regular grid. The key idea is to perform linear interpolation first in one direction, and then in the other direction.

The bilinear interpolation algorithm produces smoother image than nearest neighbor interpolation. Generally, output image by bilinear algorithm can be acquired clearer image when image is reduced.

Output pixel by bilinear interpolation is summation value of 4 nearest pixels multiplied weight and the weight is decided by linear method. Each weight is inverse proportional to distance from pixel.

2.4 Bicubic

The bicubic interpolation is a method to do multivariate interpolation in two dimensions. The bicubic interpolation estimates value at a pixel in the destination image by an average of 16 pixels surrounding the closest corresponding pixel in the source image. Compared to the blinear interpolation, the bilinear interpolation uses the value of 4 pixels in the source image. The bicubic algorithm use 4 pixels x 4 pixels and cubic expression. If image is reduced, image by the bicubic interpolation is less clear than the bilinear interpolation.

The bicubic interpolation is a big improvement over the previous two interpolation methods for two reasons:

1) The bicubic interpolation uses data from a larger number of pixels.

2) The bicubic interpolation uses the bicubic calculation that is more sophisticated than the calculations of the previous interpolation methods. The bicubic interpolation is capable of producing photo quality results and is probably the method most commonly used.

3. SIMULATION

Analysis for sub-sampling of the LHGS is performed with MTSAT-1R image on LRIT/HRIT service.

MRSAT-1R image (11000 pixels X 11000 pixels) is applicable to COMS HRIT FD image. Since size of COMS LRIT is 2200 pixels X 2200 pixels, simulation is performed by 1/5 sub-sampling for MTSAT-1R image.

Original image for MTSAT-1R image is shown as Figure 1. Original image is too small to be ignored by human visible system. Therefore, one section of original image is enlarged and illustrated in this paper. Since the section represents the most dynamic variable in pixel value of the image, the section was selected like as Figure 1.

Figure 2 is 1/5 sub-sampled image by some interpolation algorithms. That is, image is 1/5 reduced for original image. Figure 2 (a) is by nearest neighbour algorithm, Figure 2 (b) is by bilinear algorithm, Figure 2 (c) is by bicubic algorithm.

1/5 sub-sampled image is too small to be ignored by human visible system. Therefore, sub-sampled image is displayed in 5 times enlargement. Undoubtedly, sub-sampled image and original image are displayed in the identical size. That lets us to compare original image and sub-sampled image easily.

Figure 3 shows resized image with the identical sub-sampling algorithms applied to sub-sampling from HRIT to LRIT. That is, sub-sampled image by nearest neighbour interpolation is resized by nearest neighbour interpolation algorithm, sub-sampled image by bilinear interpolation is resized by bilinear interpolation algorithm and sub-sampled image by bicubic interpolation is resized by bicubic algorithm. By using same algorithm in sub-sampling, resizing, each interpolation algorithm itself is researched.

Figure 4 shows difference between original image and resized image. Difference is the smaller, difference image is black.

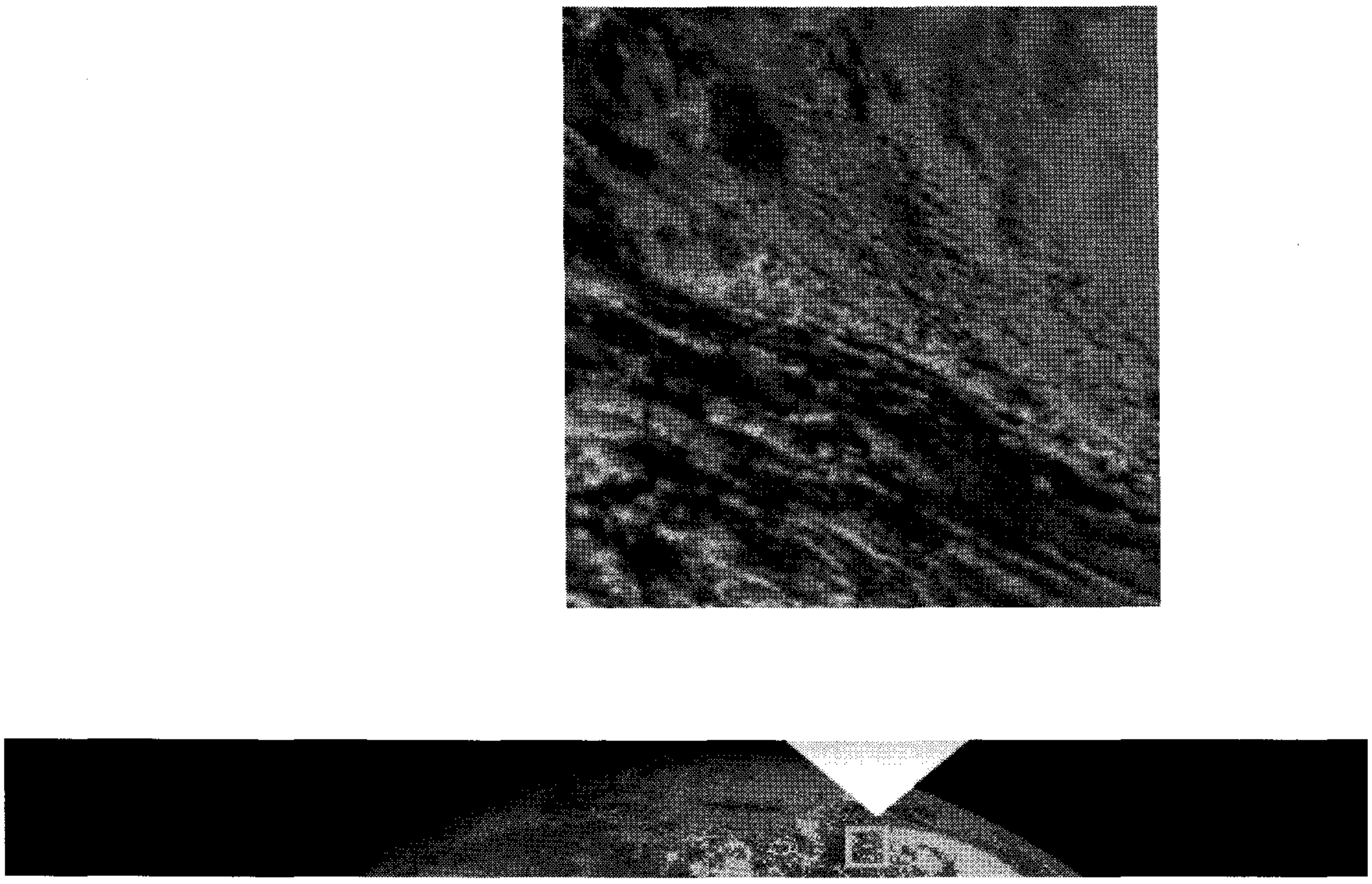
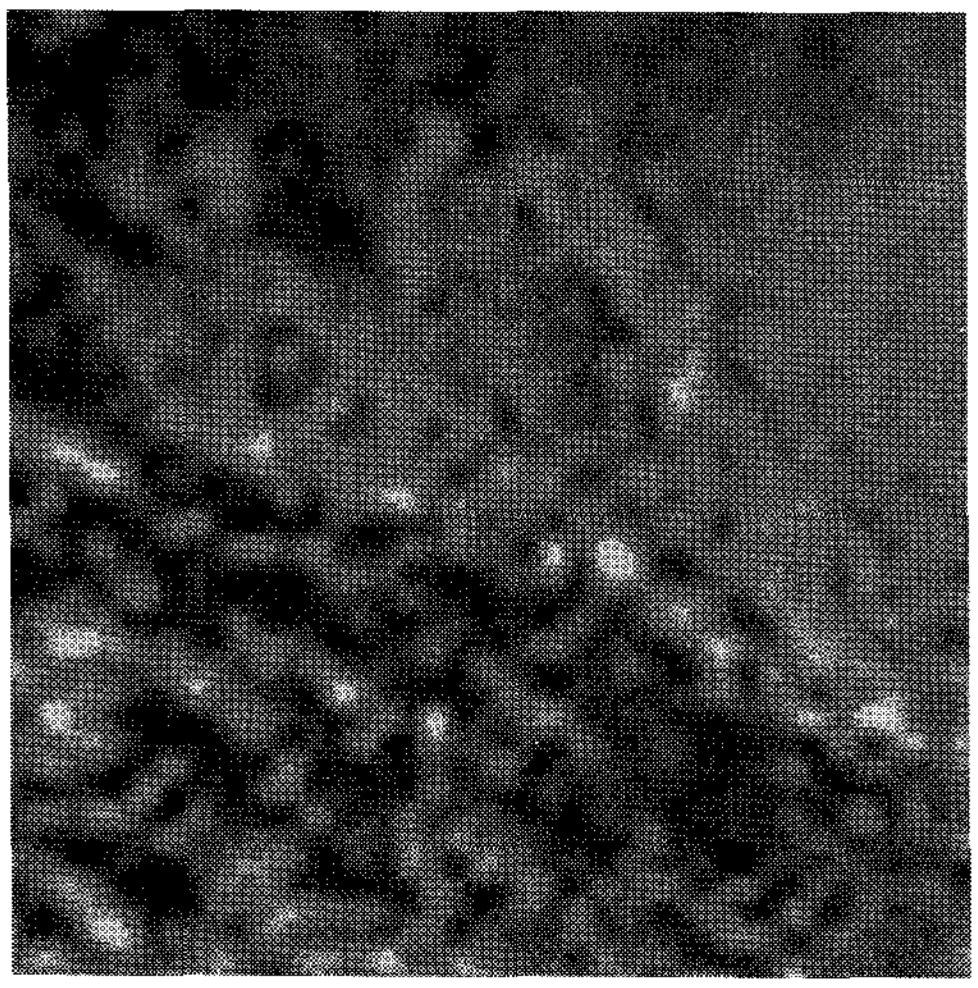
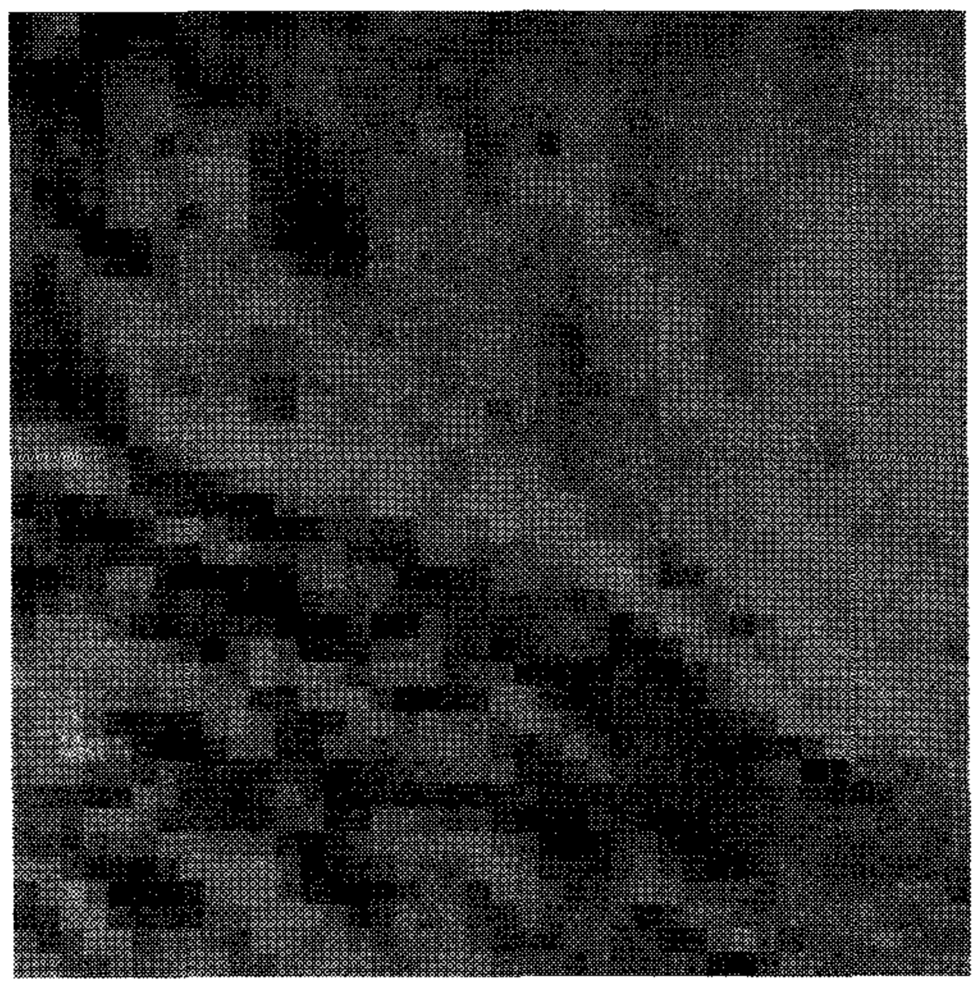


Figure 1. Original Image

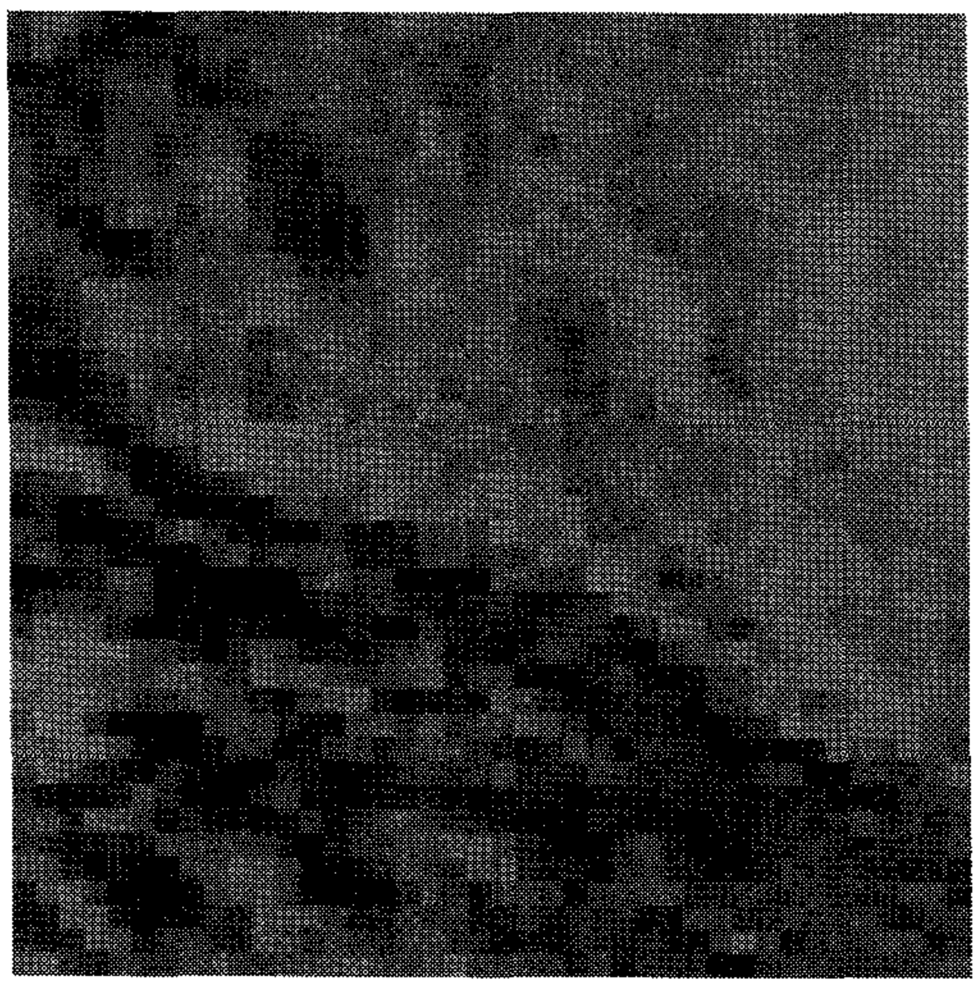


(a) Nearest Neighbor Interpolation



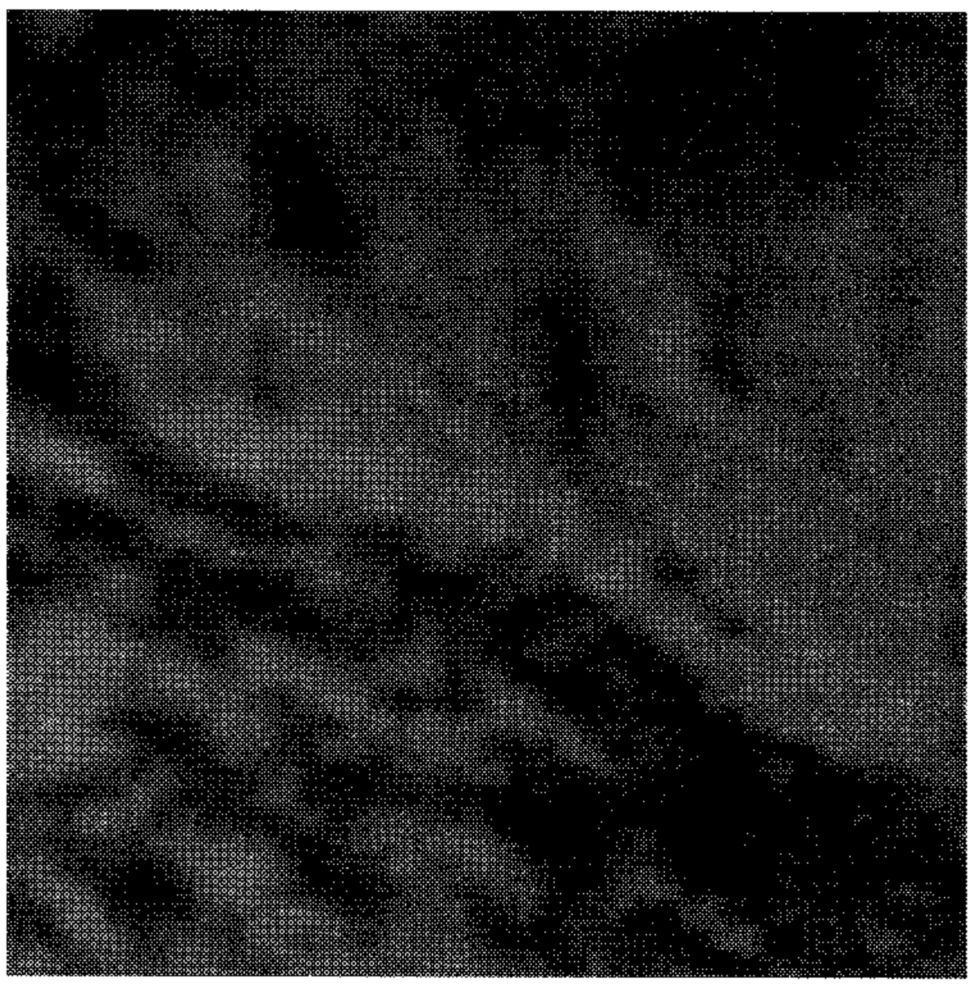
(c)Bicubic Interpolation

Figure 2. Sub-sampled Image with some interpolation algorithms

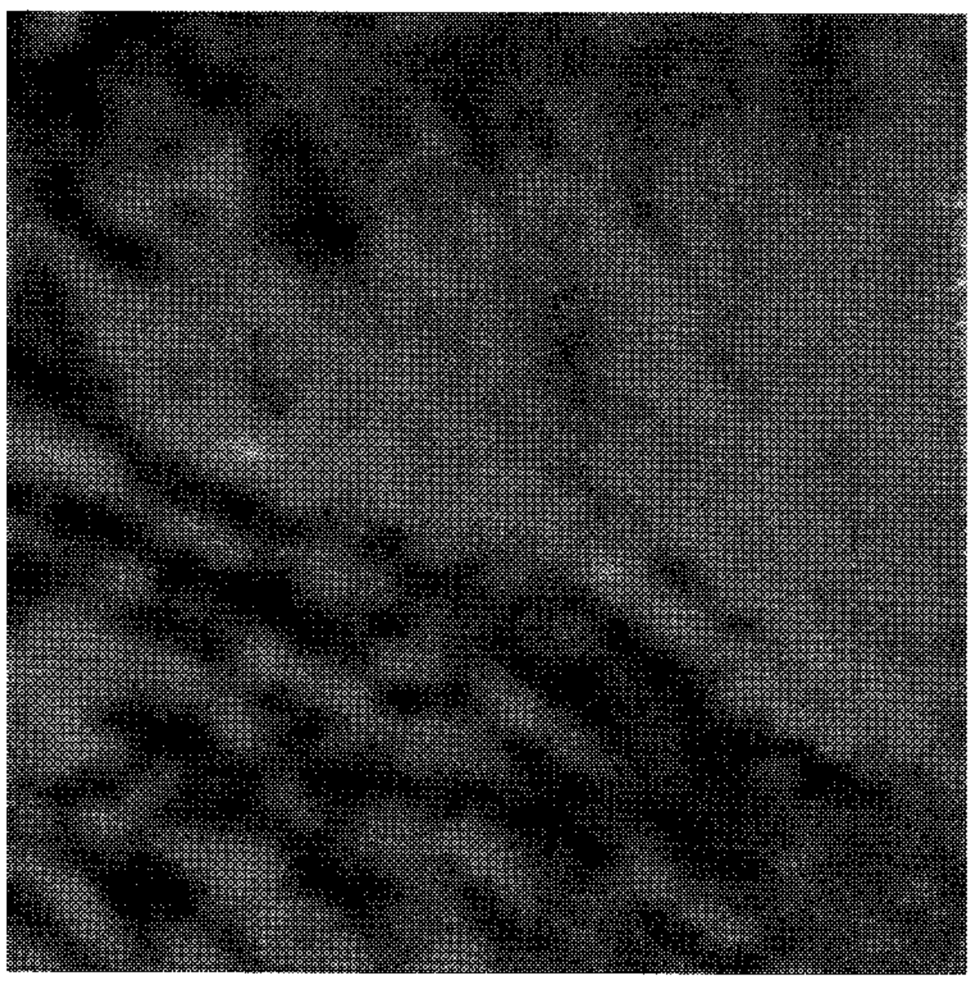


(b) Bilinear Interpolation

(a) Nearest Neighbor Interpolation



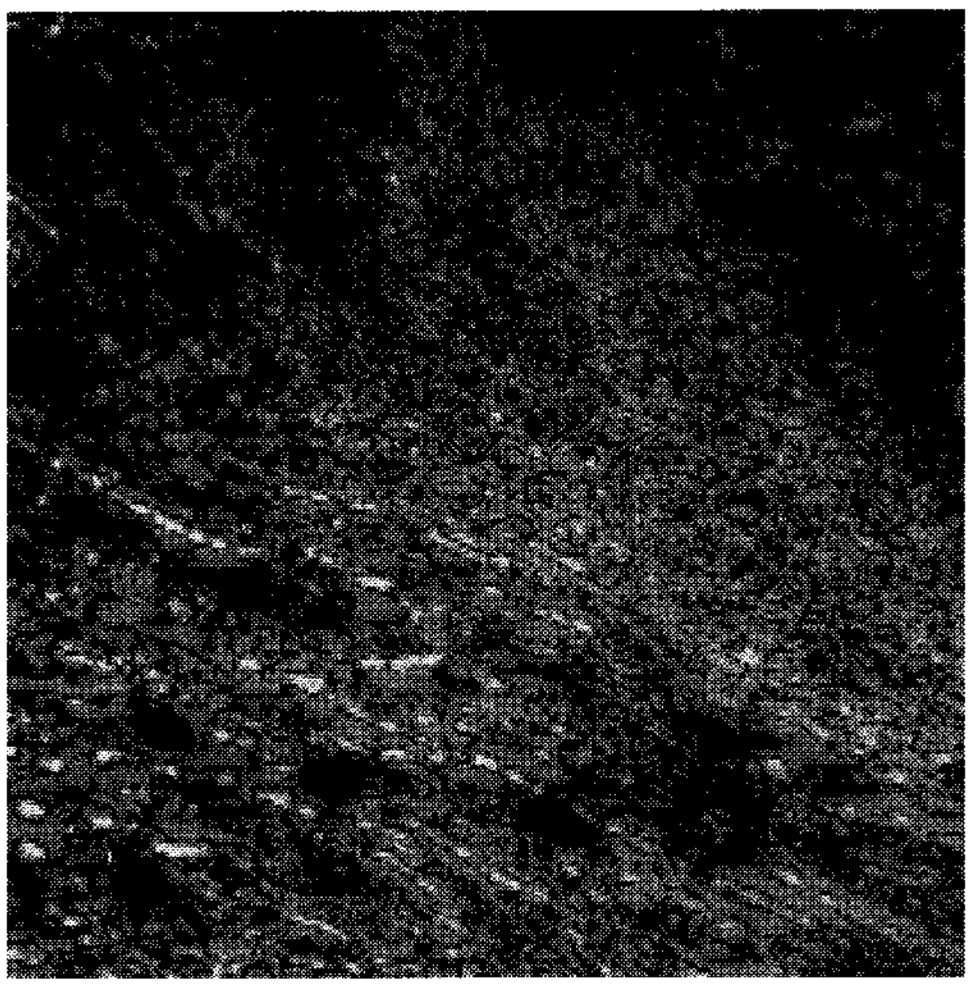
(b) Bilinear Interpolation



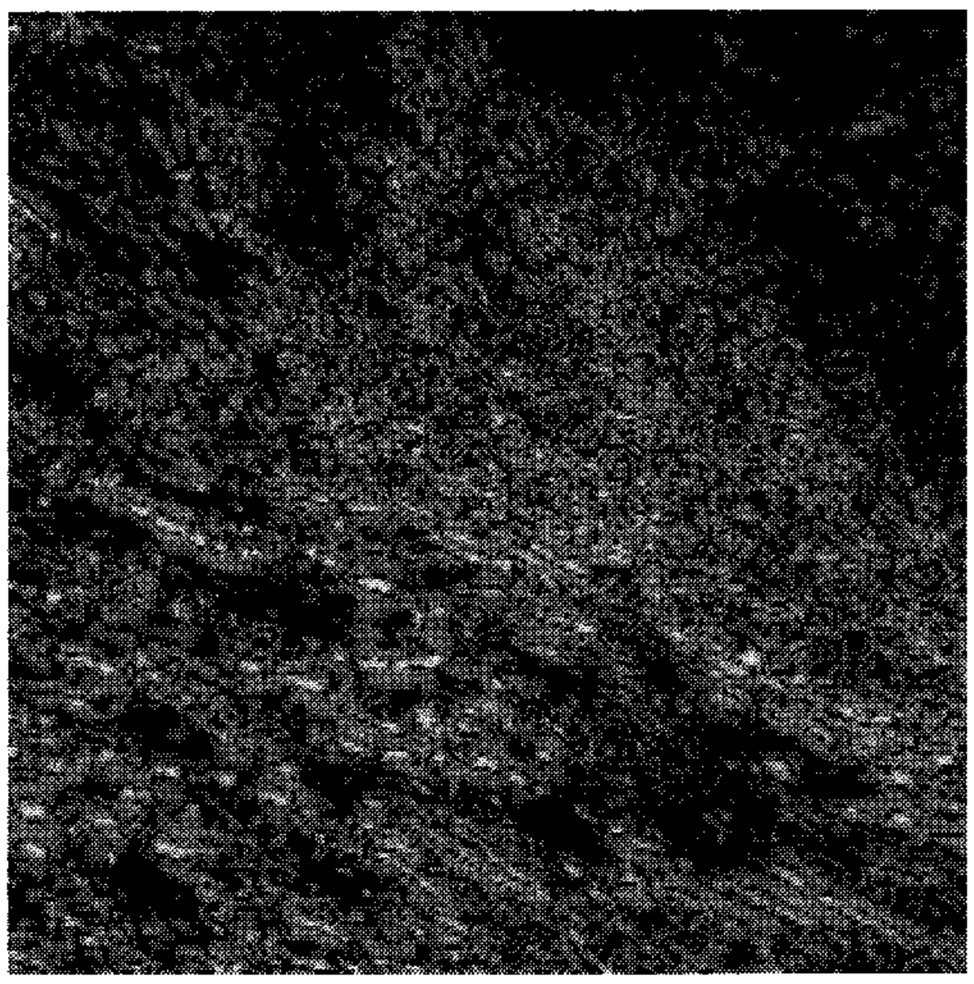
c)Bicubic Interpolation

Figure 3. Resized Image

(a) Nearest Neighbor Interpolation



(b) Bilinear Interpolation



(c)Bicubic Interpolation

Figure 4. Difference with Original image and Resized Image

4. ANALYSIS & CONCLUSION

PSNR (Peak-to- peak Signal to Noise Ratio) represents characteristic of processed image. The higher PSNR is value; the closer processed image is to the original image.

PSNR is defined as;

$$PSNR = \frac{(f_{\max} - f_{\min})}{MSE}$$

$$where \quad MSE = \frac{1}{MN}\sum_{y=0}^{M-1}\sum_{x=0}^{N-1}(f(x,y) - f_p(x,y))^2$$

MSE is mean square error. MSE is the smaller value, the closer processed image is to the original image.

M is total amount of pixel for height and N is total amount of pixel for width. $f_{\max}$ is maximum pixel value and $f_{\min}$ is minimum pixel value.

When PSNR and MSE are calculated formula above, Table 1 is acquired. Table 1 is the table of MSE and PSNR for each algorithm.

Table 1. PSNR for Some Interpolation Algorithms

Algorithm	MSE	PSNR (dB)
Nearest Neighbor	7.48	15.32
Blinear	5.87	16.38
Bicubic	5.39	16.75

Since bicubic algorithm has the highest value for PSNR and the lowest value for MSE, the sub-sampled image by bicubic algorithm is interpreted to have the best quality. As a while, the sub-sampled image by nearest neighbor algorithm has the worst quality.

The fact that bicubic algorithm or bilinear algorithm has better quality than nearest neighbor algorithm is obvious in MSE and PSNR of Table 1. But bicubic algorithm or bilinear algorithm creates an anti-aliasing effect in Figure 2, nearest neighbour algorithm does not.

The nearest neighbour algorithm is the simplest and the fastest algorithm to implement. And nearest neighbour algorithm is about 1dB difference compared to bilinear algorithm and bicubic algorithm in PSNR but generally 1dB difference in PSNR is negligible. That is, if it is considered LRIT is compressed by even lossy JPEG, sub-sampled image by nearest neighbour algorithm is little difference with that by bilinear algorithm or bicubic algorithm in quality performance for LHGS processing. And also, as shown Figure2, only nearest neighbour algorithm does not anti-aliasing. Besides, this corresponds to the guideline of user (KMA: Korea Meteorological Administration) to maintain the most cloud itself information in a view of meteorology because of no anti-aliasing. Those are why nearest neighbour algorithm is selected as sub-sampling algorithm for COMS LHGS.

Therefore, it is reasonable that nearest neighbour algorithm as a sub-sampling algorithm is used in COMS LHGS when high speed, simplicity, no anti-aliasing effects (KMA's guideline) and performance are considered synthetically.

5. REFERENCE

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