The Analysis on the relation between the Compression Method and the Performance of MSC(Multi-Spectral Camera) Image data

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ABSTRACT

Multi-Spectral Camera(MSC) is a main payload on the KOMPSAT-2 satellite to perform the earth remote sensing. The MSC instrument has one(1) channel for panchromatic imaging and four(4) channel for multi-spectral imaging covering the spectral range from 450nm to 900nm using TDI CCD Focal Plane Array (FPA).

The compression method on KOMPSAT-2 MSC was selected and used to match EOS input rate and PDTS output data rate on MSC image data chain. At once the MSC performance was carefully handled to minimize any degradation so that it was analyzed and restored in KGS(KOMPSAT Ground Station) during LEOP and Cal./Val.(Calibration and Validation) phase.

In this paper, on-orbit image data chain in MSC and image data processing on KGS including general MSC description is briefly described. The influences on image performance between on-board compression algorithms and between performance restoration methods in ground station are analyzed and discussed.

Keywords: KOMPSAT, MSC, EOS

1. INTRODUCTION

The KOMPAT-2 is the consecutive satellite on KOMPSAT-1 to provide the information for surveillance of large scale disasters and its counter-measure, acquisition of high resolution images for GIS (Geographic Information Systems), composition of printed maps and digitized maps for the territories, balanced development of Korean territories, and survey of natural resources. The MSC is a main payload on KOMPSAT-2 to accomplish the mission objectives and images the earth using a push-broom motion with a swath width of 15 km.

Since KOMPSAT-2 was launched on July 28 2006 the aliveness and function on KOMSAPT-2 was verified or validated and confirmed during LEOP(Launch and Early Operation Phase). After that, Cal/Val phase was started and all planned activities, such as performance analysis, all kinds of calibration and validation were conducted.

In this paper, the general description including the operational concept of MSC system and is explained. The on-board image chain on MSC including selected compression method and image data processing on KGS during LEOP and Cal/Val phase are described. The influence on image performance between used and to be used compression algorithm and between performance restoration methods in ground station are analyzed and discussed.

2. General Description

The MSC have been designed and developed to meet all the requirements including system performance specified in Table.1. Theses requirements were clearly tested or analyzed and verified since they were carefully assigned and controlled with mentioned hardware configuration and property at the beginning.

Table 1. The system performance requirements of MSC

Band	PAN	MS1	MS2	MS3	MS4
GSD (m)	1	4	4	4	4
Spectral Range(nm)	500 – 900	450– 520	520– 600	630– 690	760– 900
SNR	≥ 100	≥100	≥100	≥100	≥100

3. MSC Image Data Chain on KOMPSAT-2

3.1 On-board image data chain in MSC

In Fig.1 the electrical interface of MSC image data was analyzed and decided by the data rate and the MSC hardware configuration.

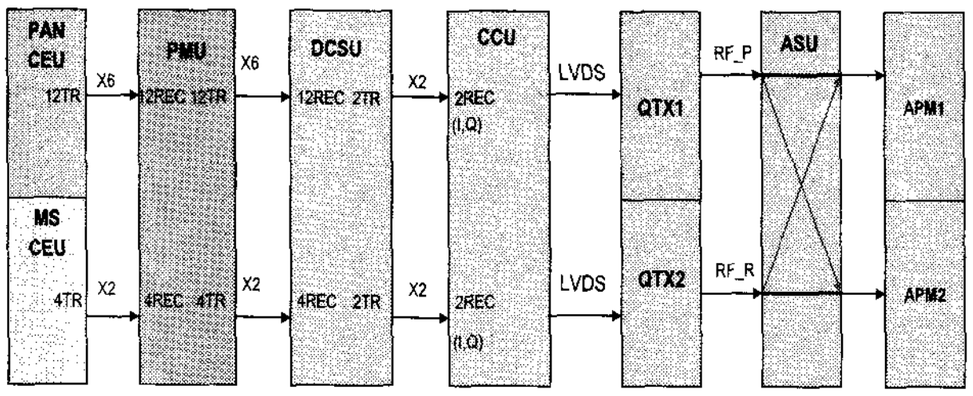


Fig.1. MSC electrical interface for image data

Around 1.3 Gbps digital image data in CEU are transferred to DCSU via NUC(Non-Uniformity Correction) in PMU by 8 channels in parallel, primary or redundant respectively. I & Q data channel in parallel, primary or redundant respectively are assigned between DCSU and CCU, and each dedicated line to QTX1 and QTX2 to transmit modulated data to KGS.

Optical information created by earth albedo is detected and converted with optimal TDI, gain and offset in EOS. Next step is the correction of non-uniformity among pixels in CCD sensor to minimize any degradation due to lossy compression which is required to match input data rate with output data rate of 320 Mbps as depicted in Fig.2.

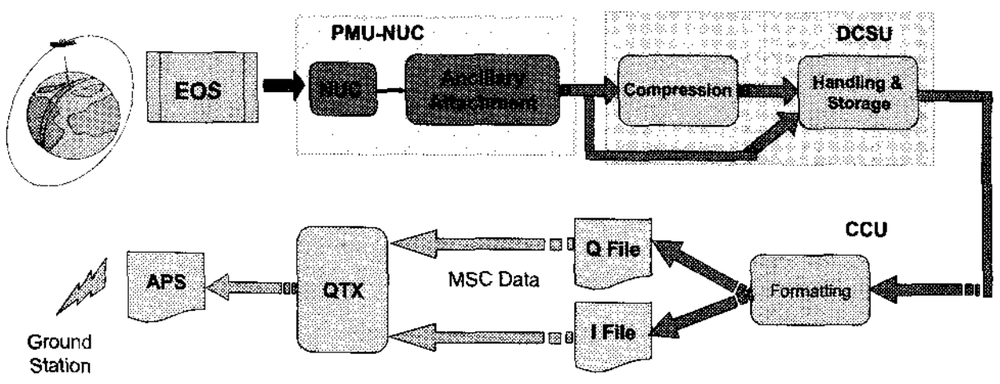


Fig. 2. The on-board MSC image data processing flow diagram

In real operation, most of parameters such as gain/offset, TDI level, compression ratio and quantization table so on, are selected to a few sets depending upon operational condition.

The JPEG-like improves compression algorithm was chosen for MSC and this is the rate controlled JPEG algorithm which is combined with rate control algorithm and JPEG based compression algorithm. The sequence of compression is similar to normal JPEG algorithm and the insignificant influence on image data from selected compression algorithm to payload performance was reported based on analysis results before the launch.

3.2 Image data processing on KGS(KOMPSAT Ground Station)

The received MSC data is processed in reverse way of on-board data handling. First step is receiving and recovering to decompressed data in DIS(Data Ingest system) and start next step to make standard data format. And then radiometric and geometric correction is applied including restoration and enhancement if required. The major activity of restoration is applying the deconvolution filter which come from MSC PSF(Point Spread Function) and/or smoothing filter.

Since KOMSPAT-2 have successfully been launched and finished IAC(Initial Activation and Checkout) phase as a part of LEOP lots of Cal./Val. activities were planned and conducted to have all necessary parameters for better performance in KGS. And the normal calibration activity is periodically continuing as planned.

4. The Influence Analysis on Data Performance

As mention in previous section, the influence on payload system performance by compression was analyzed and reported to insignificant results. But, in practice, the performance is mixed with atmosphere condition, parameter setting and calibration status as well as compression and better quality image data is continually requested. Therefore the analysis on whole image chain from on-board to ground station is needed.

In this paper, all necessary tasks including additional compression method which will be used for next KOMPSAT are define on the basis of above design and experience and divided to several task to check the real influence. Each task is plan to create simulated data from no compressed MSC data and compared with original data as described in Table.2.

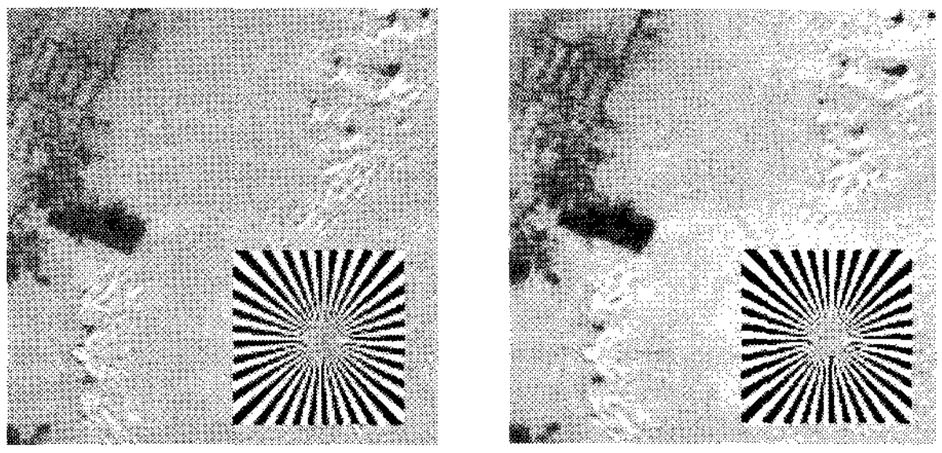
Table 2. Defined task for analysis

	Compression Method		MTF restoration (Filter)	
	JPEG	Wavelet	Deconvolution	Deconvolution + smoothing
Task1	√			
Task2	√		√	
Task3	√			√
Task4		√		
Task5		√	√	
Task6		√		√

In advance of the preparation and activation, the feasibility study for clear understanding and see the necessity was considered and conducted. The well characterized image data for the major performance with reference image, simulated Siemens star, is selected to check the difference between JPEG and wavelet algorithm.

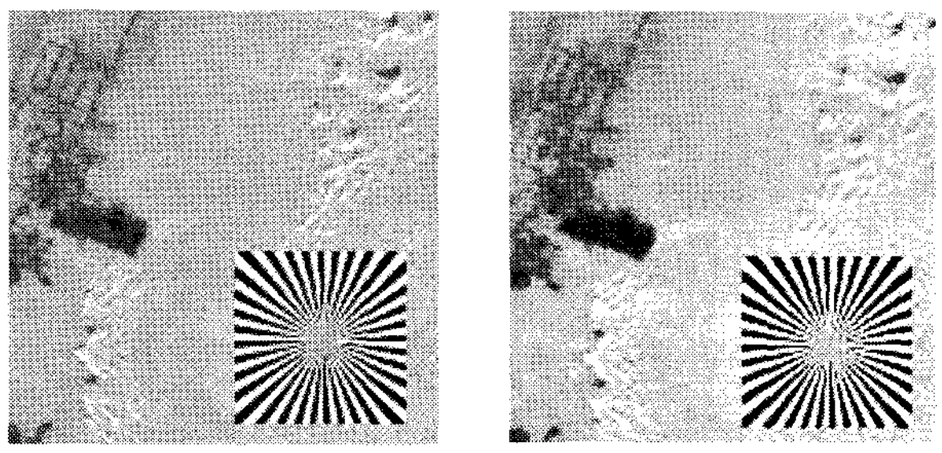
The original data and simulated result which is decompressed data is shown in Fig.3 and Fig.4. The difference between original data and between simulated data can be observed, such as smoothing in the center of

siemense star, blurring in narrow stream line and block artifact so on. It can be pre-study for on-board part of image chain.



(a) Original (b) Wavelet compression

Fig.3. The analysis result on Wavelet (CCSDS standard 122.0) CR=10



(a) Original (b) JPEG compression

Fig.4. The analysis result on JPEG-DCT extended mode CR=10

As explain in section 4, separate few simulated image data including original data are being collected and selected for analysis. They are to be analyzed by common data performance methods and the results will clearly show the influence and the distinction between compression algorithms as well as between restoration methods in near future.

5. Conclusion

Multi-Spectral Camera(MSC) is a main payload on the KOMPSAT-2 satellite and has one(1) panchromatic channel and four(4) multi-spectral channel in the spectral range from 450nm to 900nm with the functions of programmable gain/ offset and on-board image data compression/ storage.

The compression algorithm on KOMPSAT-2 MSC was selected and used to match EOS input rate and PDTS output data rate in on-board image data chain. At once the MSC performance was carefully handled to minimize any performance degradation so that it was analyzed and restored in KGS(KOMPSAT Ground Station) during LEOP and Cal./Val.(Calibration and Validation) phase.

Before final activities, the feasibility study was conducted to have a clear understanding and see the necessity. The well characterized image data with simulated Siemens star to show the major performance is selected to check the difference between JPEG and wavelet algorithm. And the difference between deconvolution filter only and deconvolution plus smoothing filter was checked by restoring results on the MSC image data.

In conclusion, the difference on on-board compression algorithms is analyzed and resulted to the comparison between the original data and simulated data using JPEG or wavelet algorithm. And the difference between the restoration methods on KGS is analyzed and observed to the comparison of before and after filter or the comparison between the restored image data through deconvolution filter only and deconvolution plus smoothing filter. Each performance influence by means of on-board compression algorithm or restoration method in ground station can easily be observed by visual comparison and numerical results by common way are to be presented.

REFERENCES

[1] S. S. Yong., H. P. Heo, Kong, J. P. and Kim, Y. S., *Analysis of the MSC(Multi-Spectral Camera) Operational Parameters*, Korean Journal of Remote Sensing, **18(1),** 198-203 (2002).

[2] S. S. Yong and S. W. Ra, *The Design of MSC(Multi-Spectral Camera) System Operation,* Proceedings of International Symposium on IEEE Geo-science And Remote Sensing 2004, 2004

[3] S. S. Yong, Kang, G. S., and H. Y. Paik, *The design of MSC(Multi-Spectral Camera) System Calibration Operation*, Proceedings of International Symposium on Remote Sensing 2004, 148-152 (2004).

[4] S. S. Yong, S. H. Lee, and S. W. Ra, *The Concept and preparation of MSC(Multi-Spectral Camera) System Calibration Operation*, Proceedings of SpaceOps2006 Conference on American Institute of Aeronautics and Astronautics (AIAA), 2006

[5] S. S. Yong, and S. W. Ra, *The Analysis on the relation between Compression Method and Performance Enhancement of MSC(Multi-Spectral Camera) Image data*, Proceedings of SPIE Remote Sensing Conference, 2007