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Improved Visualization Method for Infrared and Water-Vapor Channels of FY-2C Satellite

Summary and purpose of paper

Usually, visualization method for remote sensing imagery with quantization level more than 256 uses only the information of upper 8-bits to display the images in black and white. In order to have a sharp visualization of infrared and water-vapor channels, an improved method based on non-linear compression technique is proposed for FY-2C, which gives a sharp visual effect of the imagery, adequately representing the high detecting capability of the instruments.

Improved Visualization Method for Infrared and Water-Vapor Channels of FY-2C Satellite

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1. Introduction

FY-2C is the operational geostationary meteorological satellite of China. Its main instrument payload, the Visible and Infrared Spin Scan Radiometer (VISSR) has five observational channels, including visible channel (0.55μm-0.90μm), thermal-infrared channel (IR1:10.3μm-11.3μm), infrared-split-window channel (IR2:11.5μm-12.5μm), water-vapor channel (IR3:6.5μm-7.0μm) and mid-infrared channel (IR4:3.5μm-4.0μm).

In designing the ground application system of the satellite, one of the concerns is related to the question of how to bring forth the high detecting capability of each channel of the instrument by displaying enough information on the imagery. Of course, the solution lies in designing an applicable effective visualization method.

2. Basic visualization method for infrared and water-vapor channels

The "visualization" here is referred to as the practice of representing each channel's detective information in the form of imagery with the commonly used standards. For FY-2C VISSR instrument, the quantization level for infrared and water-vapor channels is 1024 (10-bits). However, due to the limit of human eyes in identification of small objects, the common display standard supports only 256 levels for monochrome spectrum, apparently not enough to exhibit the detective capability of current system. On the other hand, though the true color mode offers the possibility to display 10-bits information with natural colors based on the three primitive colors of red, green and blue, it does not truly represent the variation of the detective energy. So it is in usual practice for remote sensing imagery with quantization level higher than 256, the visualization method uses the upper 8-bits information to display image in black and white.

3. Principle for the improved visualization method

Given the above analysis for the basic visualization method, it is understandable that the useable displaying depth is only 256 levels which can not be changed at all. Therefore, to begin with designing the improved visualization method, the question comes up to utilize the displaying machine, capability of which is limited, to represent the most attractive features of observed objects. Obviously, a feasible way is to assign a larger quantization level to objects with smaller signal range within the 8-bits display depth, by which the representative for the objects' particulars is enhanced.

We take the non-linear quantization technique for sound processing, like the μ-rule compression, as the example. The raw 10-bits detective information is compressed in a non-linear way, which reserves enough particular information, and the real compression can be expressed with the following formula (Note: usually, the received detective values are inversed before transmitted to users on the ground, so the weak signal lies in the higher part of the total dynamic range):

$$\mathbf{O} = \mathrm{int}\left[f(\mu, m) \cdot \left(2^n - 1\right)\right] \tag{1}$$

where **I** is the raw detective information and its maximal quantization bit is m (Note: here, m equals 10); **O** is the corresponding level number for display and its depth is n (n equals 8); $f(\cdot)$ is a unity function for non-linear compression; $\mathrm{int}(\cdot)$ returns a maximal integrator which is no more than the independent variable; μ is a selectable parameter, usually between 2.5 to 4.0. It should be pointed out that the final results could be given out in the form of a look-up table.

4. Subjective and impersonal evaluation for the improved visualization method

For the improved visualization method, two aspects should be concerned to evaluate it:

● **Impersonal evaluation**: Judge if slopes of the curve in the higher part of the total dynamic range from the above calculated look-up tables are between 0.5 and 1.0.

● **Subjective evaluation**: Judge by experienced experts for typical images to determine the optimal μ values for different channels.

Figure 1 gives curves from look-up tables with different μ values. Figure 2 illustrates the contrast between imagery with higher 8-bits and imagery with the look-up table using optimal μ value for the infrared and water-vapor channels of FY-2C VISSR (UTC05:29, Jul.31, 2006).

5. Conclusion

In order to display the infrared and water-vapor channels of FY-2C satellite with more sharp visual effect, an improved visualization method based on non-linear compression technique is proposed. The method fully represents the detective performance of the instruments by offering a fine image display.

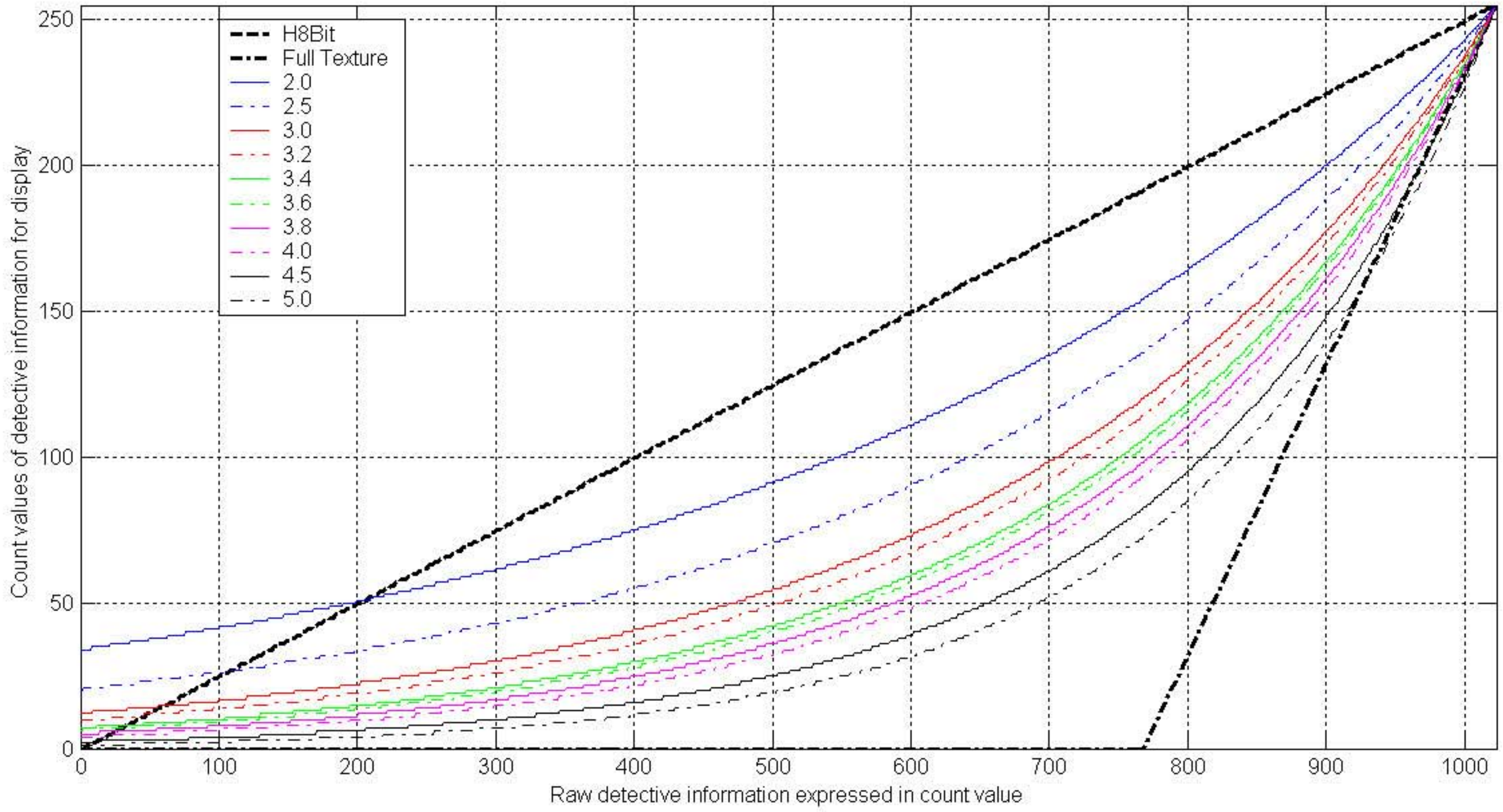
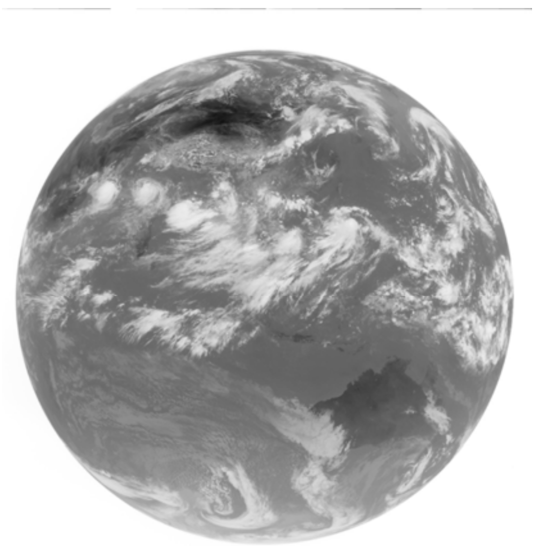
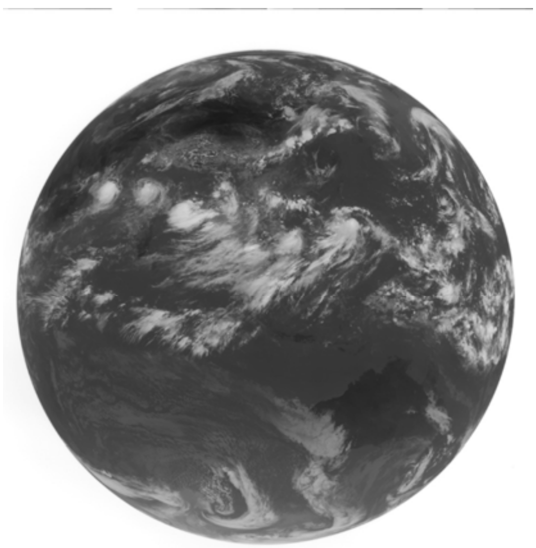


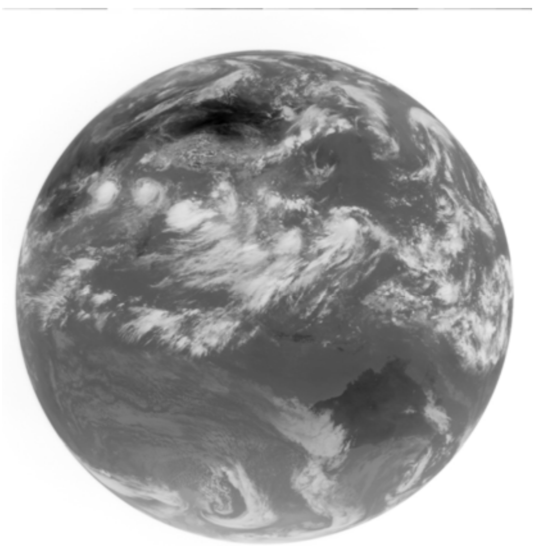
Fig.1 Curves from look-up tables with different μ values



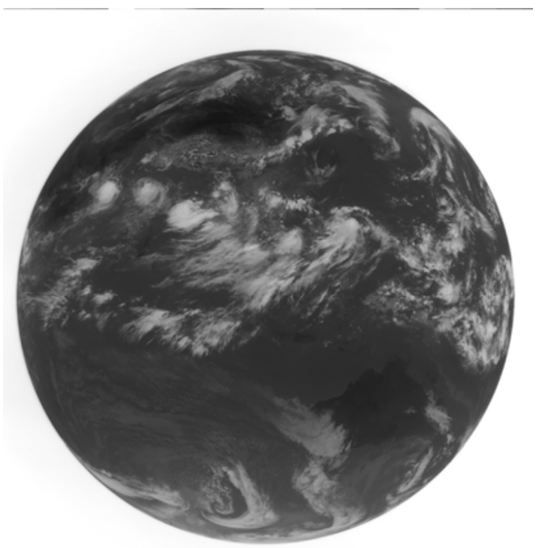
(1) IR1 Image with higher 8-bits



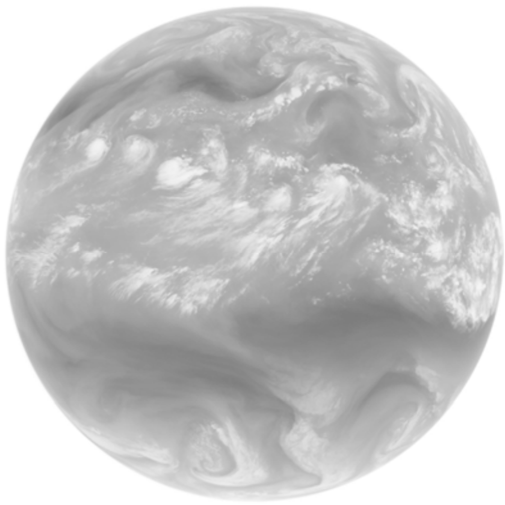
(2) IR1 Image with μ equals 2.5

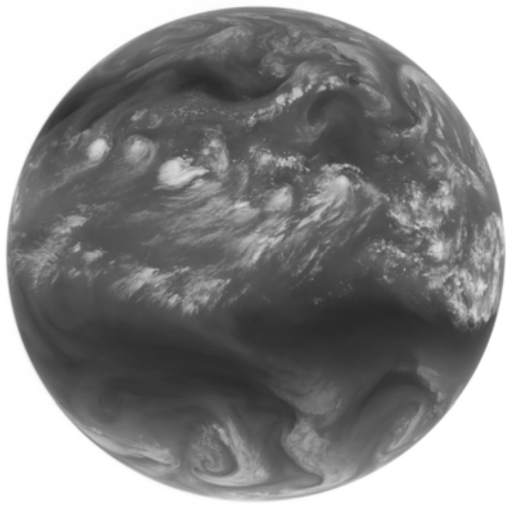


(3) IR2 Image with higher 8-bits

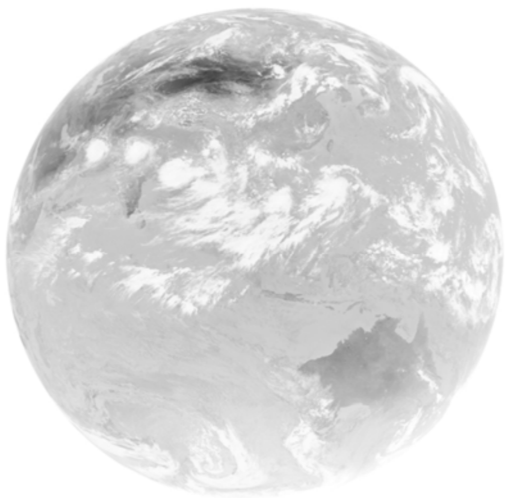


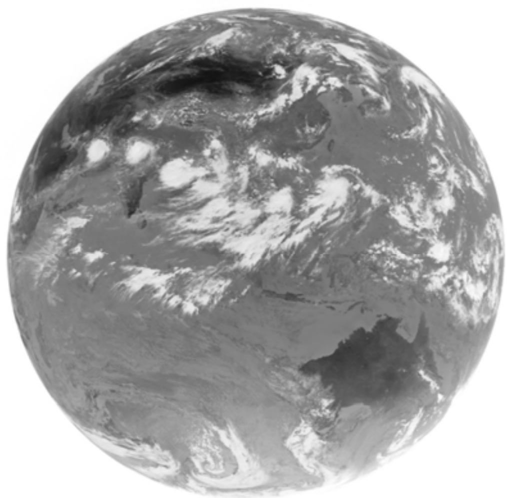
(4) IR2 Image with μ equals 2.5





(5) IR3 Image with higher 8-bits (6) IR3 Image with μ equals 3.5





(7) IR4 Image with higher 8-bits (8) IR4 Image with μ equals 3.5

Fig.2 Comparison between imagery with upper 8-bits and imagery with look-up tables using optimal μ values for infrared and water-vapor channels of FY-2C VISSR, UTC05:29, Jul.31, 2006