A NEW METHOD FOR ESTIMATING SNR FROM OPTICAL IMAGERY

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Abstract: Signal-to-Noise Ratio (SNR) is one of the basic and commonly used statistical parameters to evaluate the imaging quality of optical sensors. A number of typical SNR estimation algorithms have been developed in various research fields [1-7]. Within them, the local standard deviation method proposed by Bo-cai Gao has become a widely used one for a variety of remote sensing images, including panchromatic images, multi-spectral images, and even imaging spectrometer data. However, a relatively large region (usually hundreds of pixel by hundreds of pixel at least) with rather good uniformity in the image is needed when using the local standard deviation method. This precondition is not easy to be met, for in a common remote sensing image, uniform regions usually would not extend so far due to multiplicate limitations. Nevertheless, it is not hard to find some relatively small regions with sufficient uniformity. But unfortunately the local standard deviation method behaves unstable and may lead to severe errors when it is used on small image regions.

In this paper a new method which is suitable for estimating SNR on a small image region is presented and algorithm tests with simulated noisy images and actual remote sensing image are performed. In addition, estimated values are compared with those derived from the conventional local standard deviation method, and the advantages of the new method can be easily observed.

In brief, the new method for SNR estimation proposed in this paper consists of following steps:

1. A relatively uniform region is chosen from the remote sensing image which is to be investigated the SNR quality. Note that absolute uniformity is not required, and relative uniformity is

enough.

2. Select a small block size for oncoming image dividing. For example, the block size of 3x3 is assumed now.
3. Use certain pixel of the image region chosen in step 1 as the starting pixel for image division. For the first turn, the most upper-left pixel (i.e., the pixel (1,1) in the region) acts as the starting pixel.
4. The image region chosen in step 1 is divided into small blocks sized 3x3 pixels. For each small block, the local mean (LM) and the local standard deviation (LSD) of pixels within this block is calculated and recorded.
5. Set the pixel (2,1) as the new starting pixel, and carry out step 3 and step 4 for the second turn. Similarly, set the pixel (3,1) as starting pixel for the third turn. Afterwards, set the pixel (1,2) as starting pixel for the fourth turn. … Finally, set the pixel (3,3) as starting pixel for the ninth turn.
6. The mean value of LSDs of all the small blocks generated by the former steps is calculated, and the minimum and maximum of LSDs of all blocks are also found.
7. A number of bins with equal width are set up, within the range from the minimum of the LSDs to the 1.2 times of the mean of the LSDs. The LSDs of all blocks are then grouped into these bins. The number of blocks having LSDs within each bin is counted and recorded. Now a statistical histogram about the number of blocks with respect to the bin can be generated.
8. Perform a low-pass filtering processing on the statistical histogram, and a filtered histogram will be produced.
9. The bin having the peak value on the filtered histogram will be considered standing for the mean noise level of the image region.
10. The mean value of all pixels within the image region is computed and considered as the mean signal level.
11. In the end, the SNR of the image region is obtained by ratioing the mean signal produced in step 10 against the mean noise determined in step 9.

The first outstanding attribute of this SNR estimation method is that it performs multiple turns of image dividing (step 3 ~ step 5) so that plenty of small blocks can be generated even on a relatively small image region, which can lead to more stable evaluation results. The second merit of this method comes from the filtering processing in step 8, and it can effectively abate interferences due to some possibly unexpected big counts in step 7. Algorithm tests based on simulated noisy images show the method is more stable and accurate in comparison with the conventional local standard deviation method, especially when the evaluation region is not large (only 50x50 pixels for example). Tests on actual remote sensing image acquire by SPOT satellite produce some similar results.

Key words: Signal to Noise Ratio; SNR; Method; Local standard deviation; Optical image

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