An IHS-Based Enhancement Method with Improved Scale/Shift Parameter of Linear Model

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ABSTRACT:

An IHS-based enhancement method for colour images (IEM) is presented in this paper. An improved gamma transformation was applied to enhance the brightness and texture details of colour images taken in dark conditions. Moreover, a spatial filter was used to prevent the loss of details of highlighted areas. The method was tested with the images from the database of Simon Fraser University (SFU) and from the Chinese ZIYUAN-02C satellite. The experimental results show our proposed method could effectively enhance the luminance and texture of the images, especially for those taken in dim conditions, and maintain the hue and saturation of original images.

1. INTRODUCTION

Remote sensing images have played an important role in many applications, such as objective detection and image interpretation. Among these applications, the visual effect is an important factor that affects the accuracy of application results. However, many factors may reduce the visual effect and degrade the image quality. For example, insufficient light lowers the image brightness and smudges the fine textures, making the detailed information difficult to be identified. In this case, images need to be enhanced prior to applications [1].

The visual effect is closely related to the capability of the display devices that show graphic images. Because remote sensing images can be shown only in a single band or in three bands simultaneously on a display device, many image enhancement techniques have been developed for panchromatic images and colour images. Among these techniques, enhancement approaches in frequency domain and space domain [2, 3, 4, 5] are popular. Although these approaches can effectively improve the contrast of images, they cannot maintain an average brightness level, which may result in either under- or over-saturation in the processed images. Therefore, these methods are not suitable for colour image enhancement. Because colour appearance is a useful feature to identify an object, it must remain roughly constant during colour enhancement. To study colour constancy, the retinex model was proposed [6]. The colour appearance of an object is believed to be determined by the surface reflectance function of surrounding objects, which is not related to the intensity of light [7]. Therefore, the colour appearance of an object can be defined by the variation of ambient light, and this appearance can remain unchanged when the intensity of the light is changed. Although many researchers established the mathematical foundations of the retinex model soon after, the model has not been applied widely to image enhancement. Then the author in [8] developed a single-scale retinex (SSR) method. It replaced the center/surround retinex with a difference of Gaussian (DOG) function. Moreover, it modified the placement of the logarithmic function in the retinex model. The SSR method can provide either dynamic range compression or tonal rendition of images, but it cannot provide both of them simultaneously [8, 9]. Therefore, a multi-scale retinex (MSR) method was developed [10]. Both dynamic range compression and tonal rendition are achieved by the MSR method; however, the method causes gray-world violation in the rendition of scenes [10]. To resolve this problem, a multi-scale retinex method with colour restoration (MSRCR) [11, 12] was proposed. Although all of these algorithms could improve the colour constancy to some extent, the hue of images may be changed as they mix the colour information with illumination [13]. To cope with the problem mentioned above, a linear transformation method (LTM) was proposed, which proved that linear transformation does not change the hue of images in the Intensity-Hue-Saturation (IHS) colour space, and the variation of saturation is decided by the scale parameter and shift parameter of linear transformation [13]. However, the scale parameter in LTM contains an experience constant, which may increase the instability of the method. Moreover, the scale parameter is not monotonic in LTM, which may result in texture distortion after enhancement. Therefore, to increase the robustness of the result, the innovation of this paper is focused on the accuracy and stability of the scale parameter. The shift parameter is changed slightly to further optimize the enhancement image quality.

2. METHOD

The main steps of the proposed IHS-based enhancement method for colour images (IEM) are as follows:

1. Transforming the image data from RGB colour space into IHS colour space;
2. Determining the scale parameter and the shift parameter of linear transformation;
3. To obtain the enhanced images, a linear transformation is performed by convolving the scale parameter with the original images. Then a shift parameter is added into the intensity component of the enhanced images to restore some detail information that is lost during transformation.