ADVANCED ALGORITHM FOR SHADOW DETECTION AND RECONSTRUCTION IN SATELLITE IMAGE PROCESSING FOR ROAD AND FOREST DETECTION

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Abstract— In urban areas, the presence of shadow in high resolution satellite images is caused a serious problem for the full exploitation of images. To solve the shadow problem in high resolution satellite images, this paper propose a new shadow detection and reconstruction algorithm. Mainly three stages are using in this paper shadow detection stage, training stage and shadow reconstruction stage. The shadow detection stage consists of thresholding method, morphological filtering method and edge compensation method. The shadow reconstruction stage consists of two phases the example based learning phase and interference phase. During example based learning method, first the pixels are sampled by manually, these samples form a shadow library and nonshadow library, which are correlated by a Markov random field (MRF). During the interference phase land cover pixels are reconstructed from the corresponding shadow pixels by adopting the Bayesian Belief Propagation algorithm to solve MRF. The algorithm is successfully tested with the datasets, QUICKBIRD, WORLDVIEW-2 and IKONOS.

Index Term- Example learning, Markov random field (MRF), morphological filtering, shadow detection, shadow reconstruction.

I. INTRODUCTION

With the technological development in aerospace much earth observation satellite images are developed. Some of the examples are QUICKBIRD, WORLDVIEW-2 and IKONOS. They have very high spectral resolution mainly range from 0.5 to 4m. VHSR images have attracted much attention from researchers studying urban areas. Shadows may inferring 3-D scene information based on their position and shape. Shadows cause partial or total loss of radiometric information in the affected areas. In urban areas, high-rise images caused shadows, it constraints of imaging conditions. Attenuate the problems by using compensating or reconstructing process. Mainly two types of shadows are occurring, Cast shadow and self shadow.

The previous research of shadow detection gives better results but also has some drawbacks. The color spaces model depends on illumination conditions and scene layout. In thresholding threshold value can be changes according to resolution of particular satellite image. The creation of accurate city 3D model is major problem in three dimensional modeling. Great diversity of geometric structures which usually exist in VHSR satellite images of urban areas. Cast shadow also depends on the direction of light. Self shadow is the part of the object that is not transmitted. In this paper proposed a new shadow detection and reconstruction algorithms.
II. PROPOSED METHODOLOGY

The flow chart shows the main steps occurring in this project. Mainly three stages are occurring there, shadow detection stage, training stage and shadow reconstruction stage. The shadow detection stage consists of three main methods, thresholding method, and morphological filtering method and edge compensation methods.

First step is thresholding method, where shadow mask is derived, the shadow mask is elaborated by the morphological filtering method and it also filters all the noise and avoid wrong shadow areas. With the effects of penumbra and the surrounding condition methods.

The shadow reconstruction stage consists of two main steps: example based training and shadow reconstruction via Bayesian Belief Propagation. Another important stage is training stage where no shadow library and shadow library are occurring and it is correlated by an MRF.

A. Shadow Detection

Thresholding method is first step occurring in this block diagram. Here linear threshold method is also using. Depending up on the threshold value we

![Flow chart of proposed method](image)

Fig 1: Flow chart of proposed method
On the basis of two libraries we can reconstructed non shadow pixels, according to the derived shadow mask in the shadow detection stage.

can extract shadow, that is shadow mask is forming there. A preliminary shadow mask is derived there. This method is according to the spectral characteristics of the MS image. The shadow mask is then derived by the following formula:

\[
M_{\tau} = \begin{cases} 
1, & \text{if } DN_{\text{NIR}} > 1 \\
0, & \text{else}
\end{cases}
\]

The shadow mask is elaborated by morphological operations and is used for filter noise and the wrong shadow areas. In the morphological filtering method opening, closing, dilation and erosion methods are also using.

The shadow edges are compensated considering the effects of penumbra and the surrounding conditions of shadow on VHSR images.

**B. Shadow Reconstruction**

It is final step where shadow mask is reconstructed. That is underlying nonshadow pixels can be reconstructed. From the corresponding shadow pixels according to the derived shadow mask in the shadow detection stage. The shadow reconstruction occurring via BBP. The following equation is used to calculate the similarity of two shadows:

\[
\text{Dist} \left[ V(i, j), \hat{V}(i, j) \right] = \sqrt{V(i, j) - \hat{V}(i, j)}^2
\]

By setting the initialization of all messages to one, the messages in are updated automatically through the following rules:

\[
m(u, v) \rightarrow (i, j) \left[ \hat{V}_n (i, j) \right] = \max_{\Sigma} m(u, v) \quad \text{where} \quad m(u, v) = \prod_{(a, b) \in \Omega(u, v)} m_p(a, b) \rightarrow (u, v) \left[ \hat{V}_n (u, v) \right]
\]

**III. EXPERIMENTAL RESULTS**

To examine the shadow detection and reconstruction images Quickbird image is also taken. By shadow detection process shadow mask is derived and is reconstructed through the shadow reconstruction method. To reconstruct the underlying scene pixels of shadows, we have developed a shadow reconstruction algorithm based on the example learning method and an MRF. The execution time of the reconstruction procedure with the growth of data amount. It is worth mentioning that we considered the effects of high-brightness areas on the adjoining shadow neighbors and integrated them into the shadow mask by employing morphological operations in the shadow detection algorithm. Another matter worth noting is that we considered the compatibility between the reconstructed shadow regions and their nonshadow surroundings and improved this issue by passing messages between them in BBP procedure.

**IV CONCLUSION**

The proposed shadow detection algorithm can derive continuous and correct shadow masks. The shadow reconstruction algorithms are consistent with their surroundings. Shadow reconstruction problems in estimating land-cover types with similar spectral characteristics. Detection algorithm can derive continuous and correct shadow masks and that the reconstructed shadow regions from the proposed shadow reconstruction algorithm are consistent with their surroundings. The classification test on images before and after shadow reconstruction demonstrates that the image after shadow reconstruction is beneficial to improve the classification performance. However, there is also improvement space for shadow reconstruction problems in estimating land-cover types with similar spectral characteristics, such as cement and road. Compared to previous shadow detection algorithms, the advantages of the proposed one are that the derived shadow region is continuous.
and the transitions between shadow and nonshadow regions are carefully considered.

REFERENCES


