AUTOMATIC CHANGE DETECTION IN A MULTITEMPORAL SERIES OF RADAR IMAGES

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1. INTRODUCTION

In the literature, several works are led around the radar images especially the detection of the cartographic objects, the 3D reconstruction and the change detection. Concerning this last application, several techniques compete to ensure the best possible result. In this paper, we aim first at developing an automatic detection procedure to compare between similarity measures. Then we propose a change detection technique based on the fusion of two similarity measures. The first one is the Rayleigh Ratio (RR) measure [1] and the second one is the Contrast (C) measure [2]. The proposed method have been validated on simulated data and then applied on three radar images.

2. SIMILARITY MEASURES

In the case of change detection between two given images, we need a criterion which allows the classification of pixels in two classes: the class of changed and unchanged pixels. The similarity measures are mathematical operators allowing the quantification of the correlation between two images to deduct the significant changes. Indeed, the application of these measures on two radar images permits to generate an image in grey levels. Many techniques exist in the literature [3] [4] to guarantee reliable criterions.

The conventional ratio edge detector is a pixel-by-pixel ratio of mean reflectivity values of the two date images. This detector is well-known and widely used in SAR imagery. To ensure the model adequacy for change detection purpose, we prefer to use the log of maximum of averaged intensity ratios which is defined as the contrast measure C. Besides, RR is a new measure which is asymptotically comparable to the C measure. It was developed from the Rayleigh Distribution which is the distribution that adequately models the speckle noise present in radar images. The most used operators to quantify the similarity measure performances are the ROC curves which permit to compare several change detection techniques.

3. SIMILARITY MEASURES VALIDATION PROTOCOL

3.1. Modeling radar images

Before beginning to work with real data, it's better to validate algorithms on simulated data. However, it is difficult to model suitably the real data especially radar images. In this work, the generated simulated images follow the Gamma distribution as radar texture. Besides, a noise following the Rayleigh distribution is added since it illustrates in a good way the speckle noise present in radar images.

3.2. Validation protocol

The proposed validation protocol consists in estimating the performances of several similarity measures on simulated images generated from various scenarios. The first one is the simplest case which consists in comparing almost homogeneous windows (with the same parameters of the Gamma distribution). This scenario can be present in the radar images in several cases such as the covering of lakes or maritime regions, etc. We suppose in the second case, that half of the pixels changes. It represents changes considered as significant in a given region. The third case concerns high reflection pixels characterizing building in radar images. To model these regions, we considered a strong contrast between the original grey level and regions with high reflection.

3.3. Comparative study between similarity measures

The comparison protocol consists in generating three small images among them the first and the second are exactly the same. The third image contains the changes following one of the three scenarios described before. Then the sensitivity and the specificity are calculated for a large number (a considerable number of representative radar samples) of iterations and for the different similarity measures. These simulated images are used to compare several similarity measures. According to ROC curves, there is not a best choice for the three scenarios. The RR measure is more suitable for the third scenario and the C measure is better for the first and the second scenario. For this reason, we propose a new similarity measure which combine appropriately the RR and the C measures.

4. GLOBAL APPROACH FOR CHANGE DETECTION BETWEEN RADAR IMAGES

To extract the most significant changes between two images, we improved the method proposed in [3]. For that purpose, we replaced the log-ratio operator by the fusion of two similarity measures that proved to be the best criteria according to the previous comparative study. The fusion between the RR and the C measures is accomplished by the associative symmetric average operator proposed in [5]. After applying the change detection process, we obtain a grey level image that have to be thresholded to discriminate the most significant changes. The change mask is obtained by using the Kittler–Illingworth thresholding technique. The validation of the proposed approach is done first on simulated data which prove that the fusion of the most discriminating measures is better according to ROC curves. Than, this technique is applied on a set of three radar images in order to monitor temporal changes.

5. REFERENCES

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